Incorporating Oral Presentations into Electrical and Computer Engineering Design Courses: A Four-Course Study

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Abstract

One measure of continuous improvement in the Electrical and Computer Engineering Department (ECE) at the University of North Carolina at Charlotte is survey feedback from alumni on their workplace readiness. In a recent survey, alumni highlighted oral communication as an area of weakness in the curriculum. When a group of faculty teaching design courses learned about the University's Communication Across the Curriculum (CAC) program, they formed a pilot team to focus on improving student oral presentation skills in the design courses.

The CAC program focuses on the oral and written communication as playing an integral role in teaching students reasoning, critical thinking, and problem solving skills. And as faculty development program, it seeks to develop a communication enhanced curriculum (CEC) at the departmental level.

The CAC program hosts an annual institute during which departmental teams gain professional development in the areas of oral and written communication. At the 2010 CAC Institute, a team of ECE faculty set the strategic goal to improve ECE students' ability to clearly convey technical information orally during design presentations. The ECE team then met with the CAC coordinator to develop an oral communication rubric for uniform implementation, thus establishing a cohesive assessment across the department's design sequence.

Our goal with this approach was to improve oral communication skills among our graduates to increase their opportunities for success in their professional careers. We focused on three important skills in oral presentation: audience analysis, message coherence / focus, and message delivery. A team of five faculty--four from ECE and the CAC director--worked together to develop a rubric to evaluate students oral presentation skills in the sophomore design (ECGR 2252), junior design (ECGR 3157) and senior design (ECGR3253 and ECGR3254) courses. The implementation of the process began by using the rubric in Appendix (a) to evaluate student and team presentations in each of the four courses above. We videotaped the presentations for students to review later so they could learn from their mistakes. We followed teams of students from the sophomore design in the spring 2012 to the Senior Design in the fall 2013, and we tracked and observed their progress from sophomore design to senior design. Our hope was that the results would justify full implementation into other ECE courses by the fall of 2014.

This paper describes the process we followed to implement this emphasis on oral communication. This paper also presents a comparison of oral communication performance before and after the emphasis on oral communications was implemented. Data collected is from measurement tools put in place six years ago for ABET Student Outcome reporting.

Introduction

The Electrical and Computer Engineering (ECE) department and the Communication Across the Curriculum (CAC) program worked together on a three-year research project to study the impact of instructors' written feedback and students' written reflections on electrical engineering students' speaking skills. Four design courses—sophomore, junior, and two senior design

classes—provided the project's framework. The research involved assessing the presentations of a select group of project students and an equal number of control group students, beginning with the sophomore design class and continuing through the two senior design courses.

The project students received feedback via an analytic rubric. The benefits of using rubrics are shown in Conrad et al [7]. The Project students viewed their videotaped presentations and wrote a reflective paper on their performances. The control group did not receive feedback, although their presentations were scored using the rubric. At the conclusion of the senior design class, a statistical analysis of the data was expected to support the project's overall objective: that student' speaking skills would improve with multiple opportunities for practice and feedback.

The ECE department was invested in this project because communication skills are criteria by which the department is judged for accreditation. The university community stands to benefit from the knowledge created because our findings address oral communication goals stated in the 2008 UNC tomorrow report, a system-wide visioning document. This project has the potential to increase student engagement in the discipline, and we hope it will become a campus-wide model of how pedagogical revision can speak to the objectives of the Quality Enhancement Program that is part of the SACS assessment.
The strategic goal of this project was to improve the oral communication skills of all undergraduate electrical engineering students. The research question was whether this strategic goal could be achieved via instructors' post-performance feedback and students' reflective writing. We investigated this question through a statistical comparison of the effectiveness of the oral presentations made by the project students with those made by a control group of students. The assessment data needed for this comparison was based mostly on the blind judgment of third-party evaluators in the second senior design class.

Project research overview
The objective of this joint research project was to test the hypothesis that students' speaking skills would improve with multiple opportunities for practice, self-reflection, and instructor feedback. The methodology was to statistically compare the speaking effectiveness of a select group of project students with an equal number of control group students after all students were given multiple opportunities for practice. However, the presentations of only the project students were videotaped for their self-assessments, and only the project students received feedback from the instructors. Four curriculum-required designs courses—namely, sophomore, junior, and two senior design classes, provide the project's framework. The project concluded in fall 2013, when third-party evaluators judged all student presentations in the Senior Design class oral presentation without knowing who the project students were.

Project Narrative
A. Specific Aims
The overall purpose of this research was to improve the oral communication skills of approximately 350 undergraduate electrical engineering students by providing multiple opportunities for practice and feedback.

The project's objective was to determine whether or not the quality of students' oral presentations improved after post-performance feedback and reflective writing. We determined this through a statistical comparison of the control group and the select group of project students.

The proposed project addressed the following research questions:
a. Is the level of audience awareness and interaction (aai) higher for the project students than for the control group?
b. Is the level of message coherence and focus (mcf) higher for the project students than for the control group?
c. Is the level of message delivery effectiveness (mde) higher for the project student than for the control group?
These questions generated the criteria by which we would evaluate the students' oral presentations. Both the questions and the criteria were generated in a July 2011 meeting, during which, after much discussion, the faculty team determined that audience awareness and interaction, message coherence and focus, and message delivery effectiveness became priority criteria because students demonstrated weaknesses in these areas.

The rationale for the project was partially driven by the Accreditation Board for Engineering and Technology's recent addition of communication standards for accrediting engineering programs (ABET 3)[6]. The current research on oral communication in electrical engineering has grown as a result of this development, along with the realization that oral presentations are frequently utilized in professional engineering practice. Hence, the ECE faculty has created programmatic student learning outcomes that address the need for students to practice communicating their ideas orally to both professional and lay audiences. To link the project to professional workplace readiness, the design faculty will continue the current practice of asking a panel of local engineers to evaluate the students' final presentations in the second senior design class. To plan this project, the ECE design team and the CAC coordinator met twice during the summer of 2011 to develop a standardized analytic rubric for use during the study. We then tested the rubric during a senior design presentation in October 2011 and revised it to improve its usability.
The impact goal of the proposed project was the creation of new pedagogy that is more effective in imparting oral communication skills to electrical engineering students in order to prepare graduates for oral presentations required for employability and professional advancement. The CAC program seeks to use the knowledge gained to assist other departments across campus who seek to improve their students' oral communication skills.

B. Literature Review
Past and current research speaks to the need for a pedagogical shift in the general engineering curricula from a purely technical focus to one that integrates written and oral communication. Darling and Dannels, in "Practicing Engineers Talk about the Importance of Talk," note that there has been a "disparity between the perceived importance of communication and the respective preparation students receive on communication related tasks" in engineering and the need to provide students with practice and preparation in speaking[1]. Currently, scholars and teachers are working with engineering departments to respond to this disparity in a variety of theoretical, curricular, and pedagogical ways. Incorporating public speaking requirements into the curriculum and aligning oral communication assignments with workplace expectations are two examples of this shift, Darling and Dannels[1]. Based on survey and interview data, one recent study recommended adjusting the engineering curricula "to include the practice of cooperative problem solving, to make evaluation of oral communication competence a component of grades"

Vest et al[2] and specifically targeted audience adaptation, language use, and style as important criteria in grading communication assignments. These findings led us to select audience awareness as a student learning outcome.

Deepening Student Engagement with Oral Communication

While graduates' workplace readiness is a compelling professional reason for integrating oral presentations, researchers have found that there are intellectual benefits, too. During the development and execution of an oral presentation, student engagement with content deepens as students analyze, synthesize, and create knowledge; thus, they are not merely transferring information (Winsor 223)[12]. Furthermore, a study of chemical engineering graduates' workplace preparation noted that one's deep understanding of technical content is reflected in the genre of oral presentations and that "technically sound" presentations, executed by confident engineers, were the most effective (Martin et al 173)[11]. Finally, an extensive study of the design presentation in engineering concluded that because students learn how to situate new knowledge for an audience and how to negotiate what was legitimate for presentation, the use of oral presentations in the classroom had "clear epistemological implications far beyond the realm of delivery" (Dannels 166)[3]. We viewed the "negotiating what was legitimate" for presentation as part of message coherence and focus.

Rubric development and iterations

At the outset, we knew we would employ a standardized rubric to both assess the students' performances and to capture data since the design course teachers were already using rubrics. In addition, the literature we reviewed supports the idea that rubrics assist students in setting performance goals, while helping them make specific revisions and/or corrections to reflect improvement (Reddy et al 437)[5] . In a study conducted in a Business Management course, Petkov and Petkova discovered that the mean percentage grade for the section that used rubrics in oral presentations was higher than the comparison group (505). And, based on research conducted by C.A. Reitmeier, L.K. Svendsen, and D.A. Vrchota, integrating rubrics into an oral communication assignment shifts the evaluation protocol from "subjective observations to specific performances" (2004, 18).

The project team recognized that the three oral presentation rubrics currently in use in the design sequence needed to be collapsed into one standard rubric for the following reasons: to create a consistent, reliable and efficient rating process for the purpose of methodology; to help students internalize the criteria early in the study; and to develop a common vocabulary for post-presentation discussions.

After multiple iterations, the penultimate version of the rubric was tested in the sophomore design course; subsequent revisions focused on reorganizing criteria into three categories: audience, content, and delivery, all of which were bolded and capitalized to increase usability during the presentation. We also provided additional space at the bottom for the evaluator comments. The final version of the rubric is in Appendix IV.

Promoting Deep Learning with Reflective Writing

The justification for implementing reflective writing in the study was grounded in research conducted by Kathleen Blake Yancey and Jane Bowman Smith on the efficacy of this practice. As Yancy and Smith note, reflection records a "student's process of thinking about what she or he is doing while in the process of that doing" (170)[8]. Both argue that self-assessment and

reflection are essential to the learning process because they are a "method for assigning both responsibility and authority to a learner" (170)[8].
In the discipline of engineering, Case and Gunstone (2003)[9] have identified two styles of approaching engineering problems: deep and surface learning. Deep learning is encouraged by metacognitive learning activities, such as reflective writing, while the latter is consistent with "plug and chug" (symbolic) approaches. Case and Gunstone (2003)[9] and Case and Marshall (2004)[10] have identified writing-to-learn activities as key to promoting deep learning and its associated metacognitive properties.

C. Methods

The sophomore, junior, and senior design classes are required for all electrical engineering students, and each course requires student teams to give oral presentations about their design projects. The table below specifies the courses and the semesters during which the study was conducted.

Sophomore Design	Spring 2012
Junior Design	Fall 2012
Senior Design I	Spring 2013 and Fall 2013
Senior Design II	Fall 2013 and Spring 2014

The sophomore design class has an enrollment of approximately forty-five during the spring semesters. Students are divided into three design teams. Each team is required to design a product to satisfy specific end-user needs, and each team is required to give three oral presentations with these three elements included: Product design specifications, conceptual designs and a detailed design/product demonstration.

We divided the sophomore design class into two groups: a project group and a control group, with similar profiles in terms of ethnic, gender, and GPA diversity. To answer the three questions posed in Section A, the following student learning outcomes (SLO) assessed competencies believed to be essential for effective oral communication skills:

SLO. a) Students will demonstrate an awareness of the audience's background knowledge and expectations by fielding questions and interpreting information in a way that is appropriate to the specific audience, be it the general public, an industry representative, or their academic peers.

SLO. b) Students will organize and focus technical material and graphics to deliver a coherent message about the new knowledge they have synthesized and produced.

SLO. c) Students will deliver the presentation in an audible voice, with minimum use of notes and filler words.

The levels of achievement of these outcomes by the project students were statistically compared with those by the control group, using direct assessment data from the four design courses. Table 1 summarizes the assessment method used. It shows the selected courses for each SLO, the metrics used to determine the levels of achievement of the SLO, and the statistical variable names analyzed in the evaluation phase.

To score the students, we used the analytic rubric shown in Appendix IV. This rubric was developed by the Electrical Engineering design faculty in collaboration with the Communication Across Curriculum (CAC) coordinator. The Electrical Engineering design faculty drafted the rubric during the May 2011 CAC Institute, and then rewrote and revised it during two meetings in July 2011 with the CAC coordinator. In October 2011 we conducted a usability test during the senior design presentation class, and then revised the test rubric to make it less cluttered, and thus more user friendly for scoring during live presentations.

The local industry engineers who evaluated the students' final presentations were not informed of who the project students were, since they represented the audience with whom our graduates will have to communicate. In addition, they were unbiased because they have no stake in the study's outcome. Therefore, the conclusions of the study was predicted to be more accurate if the rubric scores were awarded by the industry panel members were weighted more heavily than the scores from the course instructors. To achieve that weighting, each score from the panel members was given five times more weight in determining the outcome of the statistical study.

Table 1: A Summary of the Assessment Method

	Courses used for assessment	Metrics used	Statistical variable name used
SLO.a	Sophomore Design (ECGR2252) Junior Design (ECGR3157) Senior Design (ECGR3253) Senior Design II (ECGR3254)	Scores from rows 1 & 2 of the Analytic Rubric	aai
SLO.b	Sophomore Design (ECGR2252) Junior Design (ECGR3157) Senior Design I (ECGR3253) Senior Design II (ECGR3254)	Scores from rows 4 & 7 of the Analytic Rubric	mcf
SLO.c	Sophomore Design (ECGR2252) Junior Design (ECGR3157) Senior Design I (ECGR3253) Senior Design II (ECGR3254)	Scores from rows 3, 5 & 6 of the Analytic Rubric	mde

Actual Implementation

After receiving IRB (Institutional Review Board for Research with Human Subjects) approval for the project, twenty students in the spring 2012 sophomore design class were selected with consent (see consent form in Appendix I) as the project students. The remaining nineteen students served as the control group. A share-drive at N:\uncc.edu\usr8\SOTL_Project was established on the Engineering computer network (known as Mosaic) for the project students' videotaped presentations, instructors' reflective writing prompts, students' reflective essays, instructors' feedback, and all project-related assignments. A teaching assistant videotaped and uploaded the recordings of the three presentations delivered by each of the five project teams. Following each presentation, the project faculty provided written feedback to each project team at the individual level. After viewing their recorded presentations, each team wrote a one-page reflective essay on their team's performance, which included suggestions for improvement.

Selection of Project Students

Following IRB guidelines, the consent form shown in Appendix I was created and distributed to all forty students in the sophomore design class in spring 2012. The students were given one week to sign and return the forms indicating their willingness to participate as a project or a control group student. Twenty-five students volunteered to participate as the project students, and fifteen volunteered as the control group students. The extra five volunteers for the project group gave us the flexibility to select two groups of students with equal average GPA. Appendix II shows the list of all students with the students in Teams 1-5 being the project students, and students in Teams 6-10 being the control students.

Sophomore Design teams oral presentation and student reflection

In the sophomore design class, students were divided into design teams of four. Each team was assigned to design a product to satisfy specific end-user needs. Each team made three oral presentations according to the schedule shown in Table 2.

Table 2: Schedule & contents of the three oral presentations in the sophomore design class.

Date of Presentations	Content of Presentations
First Oral Presentation: Feb. 28, 2012: Control group students (Teams 6-10) March 1, 2012: Project group students (Teams 1-5)	Analyze your target market (size, income, and why you think they would be interested in your product), the need statement, the objective statement, competitive benchmarking, and an estimate of the potential annual profit. The goal of presentation should be to convince the engineering managers that your proposed project will be profitable.
Second Oral Presentation: April 10, 2012: Project group students (Teams 1-5) April 12, 2012: Control group students (Teams 6-10)	Present the design specs for your product in a table. Follow with *at least* two conceptual designs in the block diagram format; use the Analytical Hierarchy Process that leads to a decision on conceptual design selection. The goal of your presentation is to convince the engineering managers that your decision on conceptual design meets the target mark requirements.

Third Oral Presentation: May 8, 2012: All ten teams	Review the goals of the project including the need and objective statements. Review design specs, and the conceptual designs considered. Discuss your detailed design followed by cost estimation. Demonstrate the operation of your prototype at some point during your presentation. End with concluding remarks on whether all design specs were met or not. For each design spec that was not met, suggest design modifications that would help meet that spec. The goal of your presentation/demo is to convince the engineering managers that your team has followed sound design practices and has developed a reliable product that meets the needs of your target market.

Faculty Feedback The project faculty provided the project students with feedback on their oral communication skills using the rubric in Appendix IV. All such rubrics were scanned and uploaded to the project share-drive by the project TA. Each team had access only to its folders on the share-drive and could not see the faculty feedback provided for other teams.

Students' Written Reflections

At the outset, we intended to capture at least three reflective essays from each team of project students because we believed it would provide a window into the students' problem solving as it related to their oral presentations. Therefore, the project teams were asked to watch the recording of their presentations and to then respond in writing to the reflective writing prompts developed by project faculty (see Appendix III). The reflective essays were then uploaded to a designated folder on the project's shared drive.

While we hoped that the reflective writing would generate most of the benefits stated in the literature review, acquiring reflective writing responses from students proved challenging. Because this writing assignment was only given to the project students, instructors could not award points for the written work since it would create inequity with the control group students, and hence students' incentive to complete this low-stakes writing task was low. We also discovered that another barrier existed: bringing groups back together to watch the recording and then produce a written response outside of class posed scheduling challenges.

Even so, the essays we collected demonstrate students' increased awareness of the strengths and weaknesses of their presentations as evidenced by the following excerpts from their reflective essays in ECGR2252 (sophomore design), and in ECGR3157 (junior design) and in ECGR3253 (senior design). Please note that, in junior and senior designs, some teams included a combination of project and control students; hence their reflective writing essays were composed individually.

PROMPT: What did you notice about the group's interaction with the audience?

Group A: *We've noticed from the video presentation that our team was scattered during the first presentation. Preferably, whoever is closest to the computer should dictate the*

next slides, so as to refrain individual team members from consistently walking back and forth.

Group B: *After having reviewed both the video and the reviewer's notes, we as a team have come to the conclusion that as a team we need to engage the audience more as a whole, and work on the "speech" portion of the presentation so that is flows more smoothly and effectively. During our first presentation we used the highly technical terms of "ahh" and "umm" quite a few times during the speech portions of the presentation. We also tended to simply readdress the information that we had already put on the power point presentation.*

Group C: *We could implement the use of a "practice" panel to help ready ourselves for the actual presentation and to engage the audience more during the actual presentation. Use of question and answer tactics, direct eye contact, and moving around the room are also ways we could get the audience engaged. We also need to understand the difference between keeping the audience engaged and making the audience feel like that someone is trying to sell them time shares in Kansas.*

PROMPT: Make three or four directive statements recommending specific changes that the group/individual should make to improve the delivery component before the next presentation. What will you do to make those changes? What are your next steps?

Group A: *We need to elaborate more in details with our responses to the questions that were asked. To effectively eliminate the "ahh" and "umms" out of our presentations, we should practice our presentations more effectively, the use of note cards, or other important point reminder techniques could also be implemented to help eliminate the unwanted pauses.*

Group B: *We need to spend more time preparing for the second presentation. One thing that will definitely help will be practicing in the room. Watching the video gave us a unique perspective on the presentation, so we might do this on our own before the next one. One thing this video showed us was that the map on the second slide was unreadable. There were a lot of 'umms' and other crutch words from everyone, so that can be addressed by having notecards or more preparation.*

Group C: *Not restating the information that is listed on the PowerPoint in front of the audience is probably the hardest technique we have to work on. The audience is capable of reading the information, so we do not want to simply "read" the PowerPoint to the audience. This also ties in to keeping the audience engaged. We want to be able to pass the information along to the audience in both a verbal and visual format in hopes of the audience retaining twice the amount of information as they would with just the visual or verbal presentation alone.*

Junior Design implementation

Students in junior design are divided into teams consisting of three or four members. Each team must complete four projects. As part of the second and third project modules, each team is required to present its design to the instructor during a design-review session. Both sets of design-review presentations were evaluated using the rubric in Appendix IV during the fall 2012 semester. It is important to note that 17 of the 20 project students and 11 of the 19 control-group students enrolled during that semester. Five of the 19 control group students ultimately changed their major (three to computer Engineering and two to Computer Science) and were thus not required to enroll in junior design. Three of the project students and three of the control-group students took junior design during summer or fall 2013. Since these students had significantly more experience or were concurrently enrolled in Senior Design I, their results were not included. Given these logistical constraints, it was physically impossible to keep the students on the same ten teams used in sophomore design. In some cases, project students and control-group students were on the same team.

Recordings of the fall 2012 presentations were made available to the project students. Unfortunately, the audio quality was relatively poor, and the student responses to the reflective prompts were sparse. Among the seven responses received, however, there was a unanimous sentiment that participation in the project had changed the students' approach to presentation. All seven respondents noted that they were more mindful of their audience and the quality and structure of their presentations. Given the detailed senior design results presented in the next section, it is interesting to note that the student responses seem to indicate an improvement with respect to SLO.a and SLO.b and provide minimal evidence of improvement with respect to SLO.c. It is also possible, however, that the poor audio quality provided students with less of an opportunity to evaluate SLO.c.

Scores from the presentation rubrics in junior design were normalized to sit on a scale of 0 to 10, as each represents 10 of the 100 points available on project modules two and three. The average presentation score for the 17 project students was 9.1; the average grade for the 11 control group students was 8.2.

Senior Design implementation and results

In the senior design course, the students were distributed across 18 projects; we followed all thirty-seven students individually, two of the control group students changed their major to Computer Science and were thus not required to enroll in senior design.

We used the same rubric as displayed in Appendix IV to provide all project students and control students' feedback. We also received several inquiries from control students asking for more feedback after the fact; because they observed the self-learning was tremendous.

We kept the following research questions in mind while assessing all students' reflective writing:

Research Questions

a. Is the level of audience awareness and interaction (aai) higher for the project students than for the control group?

b. Is the level of message coherence and focus (mcf) higher for the project students than for the control group?

c. Is the level of message delivery effectiveness (mde) higher for the project students than for the control group?

Evaluation: The data collected from the senior design class student presentation for both project and control groups were stored on the share drive. We assumed that the standards of deviations for the two populations (project and control) were equal and the three Pooled t-tests[1] were conducted to test the following hypothesis for each pair of variables such as aai_project(μ1) and aai_control(μ2):

$H_0: \mu_1 \leq \mu_2$

$H_1: \mu_1 > \mu_2$

With a 0.05 level of significance, the p-values were used to make inferences about the population means μ1 and μ2 in each of the three tests. Tables 3, 4, and 5 show the results of the t-tests for the three variables. The p-values from the one-tail tests were compared with α = 0.05 level of significance and inferences were made following each table.

Table 3: Comparing "Audience Awareness & Interaction t-Test: Two-Sample Assuming Equal Variances (α=0.05)

	aai_project	aai_control
Mean	2.736486486	2.4609375
Variance	0.207006664	0.36749752
Observations	74	64
Pooled Variance	0.281351693	
Hypothesized Mean Difference	0	
df	136	
t Stat	3.043269092	
P(T<=t) one-tail	0.00140488	
t Critical one-tail	1.656134988	
P(T<=t) two-tail	0.00280976	
t Critical two-tail	1.977560777	

p-value = 0.00140488 < α = 0.05 indicates that the null hypothesis is rejected and that there is strong evidence that $\mu_1 > \mu_2$ for the aai sample populations. That is, the project students have shown a higher competency in this category.

Table 4: Comparing "Message Coherence & Focus" t-Test: Two-Sample Assuming Equal Variances (α=0.05)		
	mcf_project	mcf_control
Mean	2.700704225	2.450413223
Variance	0.220070423	0.289187328
Observations	142	121
Pooled Variance	0.25184831	
Hypothesized Mean Difference	0	
df	261	
t Stat	4.031203291	
P(T<=t) one-tail	3.64367E-05	
t Critical one-tail	1.650712727	
P(T<=t) two-tail	7.28734E-05	
t Critical two-tail	1.969094724	

p-value = 3.64367E-05 < α = 0.05 indicates that the null hypothesis is rejected and that there is strong evidence that $\mu_1 > \mu_2$ for the mcf sample populations. That is, the project students have shown a higher competency in this category.

Table 5: Comparing "Message Delivery Effectiveness" t-Test: Two-Sample Assuming Equal Variances (α=0.05)		
	mde_project	mde_control
Mean	2.837837838	2.7265625
Variance	0.124028138	0.229600694
Observations	74	64
Pooled Variance	0.172933072	
Hypothesized Mean Difference	0	
df	136	
t Stat	1.567567305	
P(T<=t) one-tail	0.059652985	
t Critical one-tail	1.656134988	
P(T<=t) two-tail	0.11930597	
t Critical two-tail	1.977560777	

p-value = 0.059652985 > α = 0.05 indicates that the null hypothesis cannot be rejected and that

there is no evidence that the alternate hypothesis $\mu_1 > \mu_2$ is true for mde. That is, the project students have not shown a higher competency in this category.

Discussion and Conclusions:

What did we learn from this three-year study? The stated objective of the project was to test the hypothesis that student' speaking skills would improve with multiple opportunities for practice, reflection, and instructor feedback. Based on the data collected we found the following results:

1. There is strong evidence that the project students have developed a higher competency relative to audience awareness and interaction (aai).
2. There is strong evidence that the project students have developed a higher competency relative to message coherence and focus (mcf).
3. There is no evidence of higher competency of project students group over control group relative to message delivery effectiveness (mde).

The first and second findings support our hypothesis; however, the third finding does not. Even though the project students' scores on delivery reflect a slightly higher mean, the difference is statistically insignificant. After some discussion, we arrived at some possible reasons why this occurred.

Design presentations have been in place in ECE since 1978, when it was first implemented in senior design. In the mid 1990's the practice was integrated into sophomore and senior design. Because the practice has been in place in all three courses for almost 20 years, it has become institutionalized as a disciplinary genre in oral communication. Student familiarity with the expectations of the presentation—the team approach and the prescribed time limit of 20 minutes—may explain the minimal difference between project and control students' performances. In addition, when we examine all of the factors enumerated in the delivery criterion, we acknowledged that they are more explicit, compared to the other two criteria, and within the student's control:

- Voice is clear and audible
- Rarely reads from notes/slides
- Rarely uses filler words: "um," "uh," "like," "well," etc.
- Adheres to time limit of 20 minutes
- Effective pacing

In a discussion of the results, the sophomore design professor commented that "the rubric provided a priori feedback on delivery to all students." And even though we videotaped the students in each class, the poor audio quality in junior design impeded their ability to self-evaluate, thus which leveled the "delivery" playing field between the control and project students.

While it may seem that the delivery results would point to a failure in terms of the project's objective, we recognize that audience awareness and interaction, and message coherence and

focus, are sites where significant revision and negotiation of content, both oral and visual, occurred after students received evaluators' feedback. Anecdotally, project faculty observed improvements in project students' speaking skills from their first presentation to their third. And it is important to note that the students' reflective writing is the site where students express their metacognitive awareness of that revision and negotiation.

Overall, both project faculty and students recognized that oral presentations are iterative, and practices such as peer and faculty review have a positive impact on the quality of the group's presentation. In junior design the professor noted that the project students not only produced more thoughtful visuals, but that their presentations were "far more organized" and that they engaged the audience "in a far superior manner." The senior design professor reported that the control students recognized that their performances were weaker than project students. She also pointed out that she received several inquiries from control students asking for more feedback after the fact; because they observed that their peers' self-learning "was tremendous."

In terms of actionable data, the findings justify the need for providing students with multiple opportunities for feedback over the course of the three-year design sequence. The junior design professor reported that "prior to this process, I viewed the teaching of such 'soft skills as somewhat difficult and that the ability to master them was something that would come naturally to the more ambitious students who were driven to succeed. I now feel that such skills cannot be taught effectively without some mechanism for self-reflection."

Currently, we are drawing up plans to integrate scaffolded oral communication assignments, beginning with sophomore design. To link the project to professional workplace readiness, the design faculty has continued the current practice of asking a panel of local engineers to evaluate the students' final presentations in the senior design II class. The CAC Program has recently secured the assistance of an oral communication consultant from the Communication Studies department to focus on this work. And, on a broader level, the CAC Program will use the findings to assist other departments across campus that seek to improve their students' oral communication skills. As a team of academics, we look forward to doing the good work of arming our graduates with the skills they need to succeed as professionals, both in ECE and across our campus.

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Appendix I

Informed Consent for

A Study of the Effect of Instructor Feedback and Students' Written Reflections on the Oral Communication Skills of Electrical Engineering Students

Project Title and Purpose:

You are invited to participate in a research study entitled "A Study of the Effect of Instructor Feedback and Students' Written Reflections on the Oral Communication Skills of Electrical Engineering Students". The purpose of this study is to improve the oral communication skills of undergraduate electrical engineering students by providing multiple opportunities for practice and feedback. Oral communication skills combined with technical competence is essential for your professional development and it is the main ingredient for becoming successful engineers after graduation.

Investigator(s):

This study is being conducted by the Electrical Engineering professors Mehdi Miri, Nan BouSaba, Jim Conrad, and Robert Cox in collaboration with Jean Coco, the Acting Director of the Communication Across the Curriculum Program.

Description of Participation:

All students in this design class are required to give three oral presentations related to their design projects. If you choose to participate in the research project, your presentations will be videotaped. The recorded presentations will be posted on a secure share-drive accessible only by you and the project faculty. You will be asked to review your recorded presentations and reflect in writing on how you think you can improve your oral communication skills. All recorded presentations will be held confidential and will be deleted at the conclusion of the research project. Your participation in the research project is voluntary and will in no way effect your grade in this class. You will have the right to terminate your participation at any time during the project. I need 20 of you (about half of the class) to volunteer to participate as the project students and another 20 as the control group. You can volunteer for either of these two roles by signing the appropriate place at the bottom of this document and returning it to me. Please note that by volunteering to become a project student, you are giving your consent for your oral presentations to be videotaped and for your team-level rubric data to be used in the analysis phase of this research. By volunteering to become a control group student, you are giving your consent for your team-level rubric data to be used in the analysis phase of this research.

Length of Participation

Your participation in this project will continue in the junior design (ECGR3157) and senior design (ECGR3253 and ECGR3254) classes. The nature of your participation in these classes will be the same as in this sophomore design class (ECGR2252). If you decide to participate, you will be one of the 20 participants in this study. Your last oral presentation in the ECGR3254

class will be observed by a panel from local industry and their feedback will be provided to you for your benefit.

Risks and Benefits of Participation:

There are no risks to participation in this study. The benefit of participation in this study is that you will get constructive feedback from faculty and engineers from local industry to improve your oral communication skills.

Volunteer Statement:

You are a volunteer. The decision to participate in this study is completely up to you. If you decide to be in the study, you may stop at any time. You will not be treated any differently if you decide not to participate or if you stop once you have started.

Confidentiality versus Anonymity:

Any information about your participation, including your identity, is confidential. The following steps will be taken to ensure this confidentiality: All recorded presentations will be posted on a secure share-drive accessible only by you and the project faculty. The recordings will not be shown to anyone else and will be deleted at the conclusion of the spring 2014 ECGR3254 class.

In case the results of this study are published, the data collected by the oral presentation rubrics (see attached) shall be anonyms and will not contain any identifying information or any link back to you or your participation in this study.

Fair Treatment and Respect:

UNC Charlotte wants to make sure that you are treated in a fair and respectful manner. Contact the University's Research Compliance Office (704.687.3309) if you have any questions about how you are treated as a study participant. If you have any questions about the project, please contact Mehdi Miri (704-687-8416, miri@uncc.edu).

Participant Consent:

_____	_____	_____
Project Participant Name (PLEASE PRINT)	**Project Participant Signature**	**DATE**
_____	_____	_____
Control Group Participant Name (PLEASE PRINT)	**Control Group Participant Signature**	**DATE**
_____	_____	
Investigator Signature	**DATE**	

APPENDIX II

ECGR 2252 "Electrical Engineering Design I" Team Roles - Spring 2012									
Team	Name	Leader	Recorder	Optimist	Pessimist	Analyst	Decision Process	Conflict Resolution	Contact & Avail Info
1	Project student # 1		✓						✓
	Project student # 2				✓	✓			✓
	Project student # 3			✓		✓			✓
	Project student # 4	✓							✓
2	Project student # 5			✓			6	Communication	✓
	Project student # 6					✓			✓
	Project student # 7				✓				✓
	Project student # 8	✓	✓						✓
3	Project student #9			✓			6	Group Hearting & Consensus	✓
	Project student # 10				✓				✓
	Project student # 11	✓							✓
	Project student # 12		✓			✓			✓
4	Project student # 13	✓					6	Focus on performance and ideas	✓
	Project student # 14		✓						✓
	Project student # 15			✓		✓			✓
	Project student # 16				✓				✓
5	Project student # 17					✓	7	Communication and mediation	✓
	Project student # 18			✓					✓
	Project student # 19	✓							✓
	Project student # 20		✓		✓				✓
6	Control student # 1			✓			6	Listen to each other and talk it out	✓
	Control student # 2	✓							✓
	Control student # 3		✓						✓
	Control student # 4				✓	✓			✓
7	Control student # 5	✓				✓			✓
	Control student # 6		✓						✓
	Control student # 7			✓					✓
	Control student # 8				✓				✓
8	Control student # 9		✓		✓		7	communication and consensus	✓
	Control student # 10					✓			✓
	Control student # 11	✓		✓					✓
9	Control student # 12				✓				✓
	Control student # 13	✓	✓						✓
	Control student # 14			✓					✓
	Control student # 15					✓			✓
10	Control student # 16			✓			6	Listen, and talk it out	✓
	Control student # 17	✓							✓
	Control student # 18		✓						✓
	Control student # 19				✓	✓			✓

APPENDIX III

Reflective Writing Prompts
(Please write a one-page response per team in sophomore design, individually in Senior Design and upload to subfolder named "Self-Reflections")

By reflecting on your presentation performance and by articulating that self-assessment of the performance, you can gain some understanding of where you are now as a presenter, what has challenged you in this mode, and what you have accomplished at this point. Thus, the purpose of responding to these reflective prompts is to describe that understanding and those accomplishments to your professor, and to provide a starting point that will document how your oral presentation skills develop over time with practice and feedback.

Read these questions before you view the video of your performance, and then take notes while you watch the video to gather evidence and detail to develop the reflective piece.

AUDIENCE AWARENESS

How prepared were you to interpret information for the stated audience? What was challenging about this aspect of the presentation, especially the question and answer portion?

What did you notice about your group's interaction with the audience when you viewed the video? Review the Q&A portion of the presentation. Critique the responses given and suggest how they might be improved.

How did the physical arrangement of the presentation impact the group's ability to interact with the audience? If there were barriers to communication, how might you address them?

DEVELOPMENT AND ORGANIZATION OF KNOWLEDGE

Consider the transitions from speaker-to-speaker in the video—how effective are they? How might they be improved?

How did planning and developing the oral presentation and the accompany graphics help you deepen your understanding of the technical content or "new knowledge" you have gained?

How was your performance impacted by your level of interest in the specific aspect you spoke about as a member of the team?

DELIVERY

Make three or four directive statements recommending specific changes that the group/individual should make to improve the delivery component before the next presentation. What will you do to make those changes? What are your next steps?

Write out at least two things that you think were particularly strong about the presentation. Back up your comments with specific examples from the video.

Appendix IV Actual rubric used to assess the team presentation.

Analytic Rubric for Oral and Visual Communication

Name _____ Evaluator_____

Category	3. **Excellent**	2. **Satisfactory**	1. **Deficient**	**Score (1-3)**
AUDIENCE *Awareness of audience's prior knowledge and needs*	Excellent awareness of audience's prior knowledge & needs Appropriate dress	Adequate awareness of audience's prior knowledge & needs Suitable dress	Lack of awareness of audience's prior knowledge and needs Inappropriate dress	
Interaction with audience	Engages audience with enthusiasm Maintains eye-contact Conducts Q&A with clear answers & explanations	Engages the audience with some enthusiasm Makes some eye contact Conducts Q&A with adequate explanations	Lacks engagement with audience Makes little eye contact Lacks knowledge to conduct Q&A	
CONTENT *Visual depiction of ideas*	Superior visuals facilitate message delivery Frequently employs prototype	Average visuals facilitate message delivery Sometimes employs prototype	Weak visuals detract from message delivery Rarely employs prototype	
Focus	Focuses presentation by providing context	Provides some context to focus presentation	Fails to focus presentation by providing a context	
Organization	Sequences ideas logically Compelling introduction Strong, clear conclusion	Acceptable sequence of ideas Suitable introduction Adequate conclusion	Neglects to sequence ideas Weak introduction No clear conclusion	
*Quality of technical conten*t	Technical content is clear and accurate Proper, accurate references	Technical content is satisfactory Uses adequate references	Technical content is lacking Fails to use proper, accurate references	
DELIVERY *Projection* *Elocution* *Filler word usage*	Voice is clear and audible Rarely reads from notes/slides Rarely uses filler words: "um," " uh," "like," "well," etc.	Voice usually clear, audible Sometimes reads from notes/slides Uses some filler words	Voice is unclear and inaudible Reads from notes too often Filler words interfere	
Time and Pacing	Adheres to time limit Effective pacing	For 20 min. allocated, team breaches limit by +/-3min. At times pace is too fast or too slow	For 20 min. allocated, team breaches limit by +/-5min. Pace is uneven: too fast or too slow	

Evaluator's Comments: **Total:** **/ 24**