

AC 2010-1970: REFINEMENT AND INITIAL TESTING OF AN ENGINEERING STUDENT PRESENTATION SCORING SYSTEM

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Refinement and Initial Testing of an Engineering Student Presentation Scoring System

Abstract

We have previously created and beta tested a workforce-relevant, research-based scoring system for use with engineering student presentations across multiple contexts. Since then, we have systematically validated, refined, and tested the rubric in a five-step process described in some detail for this paper. First, we tested the face validity and usability of the instrument via the collection of additional feedback during focus groups and interviews with: faculty possessing expertise in scoring system design, faculty with experience in engineering design projects that involve student presentations, and additional faculty from a variety of backgrounds. Second, we used this feedback to reduce overlap and complexity in the scoring system items. Third, teaching assistants and the researchers used the scoring system items to provide feedback to approximately 140 students on presentations in a senior design course. Fourth, we made additional modifications and simplifications to the system based on the insights gained from the TA feedback process. Fifth and finally, three raters applied the resulting scoring system to several videotaped student presentations to check for inter-rater reliability and evidence of construct validity. Based on the methodology above, we reduced the instrument from 36 items to 19 items. These items include using concrete examples and details familiar to the audience; consistently referring to how key points fit into the big picture; using graphics which are visually appealing, easy-to-understand, and include helpful labeling; and effectively combining energy, inflection, eye contact and movement; among others. This paper includes a description of the process used to create the instrument, a description of the instrument, the supplemental teaching guidelines under development, and a discussion of the materials' potential for use across many engineering contexts.

Introduction

At Georgia Tech, with funding from the Engineering Information Foundation and approval from the Institutional Review Board for research with human subjects, we have created and beta tested a workforce-relevant, research-based scoring system for use with engineering student presentations across multiple contexts. The scoring system is designed to enhance students' presentation skills so they can perform better in class, get a better job, and move quickly up the career ladder. In addition, the system addresses needs for outcomes assessment in communication skills for ABET, can improve the reliability and validity of scoring for engineering student presentations by faculty, and serves as a tool to help match instruction to the assessment and evaluation of student performances involving engineering communication.

In this paper we cover three aspects of the scoring system, its development and its use. First, we describe the current version of the system along with examples from the supplemental teaching guidelines for professors and teaching assistants to use when instructing, assessing, and evaluating engineering student presentations in any university. Together, these tools provide the basis for providing presentation instruction, even by instructors who are not experts in

communication. Second, we documented the process of developing the rubric so others who intend to pursue the development of similar systems now have a robust set of procedures that can be used to ensure their product is based on sound research practice. To our knowledge, such a documented process has not been published before. Third, we emphasize that the tool provided is unique because its workforce relevance has been built in from the very beginning. Formally gathering and analyzing input from executives who hire our engineering students and are themselves engineering success stories give these tools a real-world applicability that will motivate students. This system not only addresses the faculty's need to grade students; it also directly represents what industry wants these students to be able to do when they are hired as graduates.

As a whole, the work described here provides two different valuable pieces that make up the student engineering presentation scoring system. These pieces are the (1) scoring rubric itself for use in rating presentations and (2) supplementary teaching guidelines to provide deep understanding of the items in the scoring rubric for instructors and to use when determining what instructional feedback will be helpful to students.

Background

What other well-documented scoring systems for engineering presentations are currently in use?

Our rubric-building process has taken into account various other available rubrics. Iowa State developed and tested the most comprehensive communication rubric to date, which is now in use at several other universities and colleges.^{1,2} Oral presentation rubrics are now in use at many other academic institutions, including Carnegie Mellon, Louisiana State University, Oklahoma State, Penn State, University of Arkansas, University of Illinois, University of Wisconsin, Utah State, and Virginia Tech.³⁻¹⁰ Oral presentation rubrics have been described in books as well, for example, by Michael Alley and Jean-luc Doumont.^{6,11}

To our knowledge, few of the steps used to create the available rubrics are published. The Iowa State work is one exception: it drew upon rubrics used by universities, state education associations, high schools, and Boards of Education.¹² Another is Doumont's work, which he describes as based on experience and common sense. Although this common sense approach can work well, it is much more valuable (in terms of content validity and workforce applicability) and engaging if the content of a rubric can be systematically designed to incorporate data directly from the workforce. We add significant value to the rubric development process with a systematic, detailed description of the process we used. Further, because we gathered data about engineering communication directly from executives in the workforce, the rubric presented below is highly relevant for engineering students.

Again, to our knowledge, a number of oral communication rubrics are available, mostly on web sites. But only in a few cases have any steps used to create the rubric been described. Our review has indicated that none of these rubrics has been based on executive input, as ours is. Building on this foundation results in a rubric very relevant to engineering students in becoming successful in their first jobs and as they ascend the career ladder.

A few resources about how to create effective rubrics

The literature contains a wealth of information about the broader array of rubrics and scoring systems. This includes various systems for creating rubrics or scoring systems, and a few step-by-step processes) for putting together a rubric to ensure that its content is consistent with course goals and outcomes. The selected resources below are representative of the broad information available to describe how rubrics can be effectively implemented. Mullinex explains the types of rubrics and their uses.^{13,14} This resource contains an abundance of links to additional resources and information which does not need to be repeated here. Mueller provides another excellent resource including step-by-step descriptions of how to create two different kinds of rubrics.¹⁵ Additionally, Bargainnier has written a short summary about rubric fundamentals which describes the importance of tying the rubric content to student performance in realistic contexts.¹⁶

Why having such a tool is important

ABET accreditation criteria^{17, 18} drive significant amounts of activity relating to the use of scoring systems or rubrics across the nation at colleges of engineering. Many of criteria correspond to non-technical learning outcomes such as oral and written communication. Scoring systems or rubrics can help to address that issue.

Why this work is unique

In the discussion above, a description of how specific content is selected for inclusion in a scoring system or rubric appears to be missing. This paper describes a process for collecting and refining data that can lead to strong, real-world contextual items and description of the resulting scoring system.

Methods

Separate sources describe the original design for the scoring system.¹⁹⁻²² This design was based on 1) input from executives during structured focus groups, phone interviews, and panel discussions, 2) input from faculty in engineering and communication during focus groups and individual interviews, and 3) a review of relevant literature. Since then, a beta testing process has been applied to the rubric during the summer and fall of 2009. This beta testing process involved several steps.

First, the face validity and usability of the instrument were tested. This occurred via the collection of additional feedback during focus groups and interviews with faculty possessing expertise in scoring system design, faculty working with students conducting engineering design projects that involve student presentations, and additional faculty from a variety of backgrounds. The two major instances where feedback was collected occurred in workshop presentation settings at national conferences. At the Process Education Conference in July of 2009, a draft copy of the initial rubric was presented in a 1-hour workshop session.²⁰ During the session the authors first explained the purpose of the scoring system along with the process used to create the rubric and introduced the content of the rubric to the audience. Feedback was then gathered

from the approximately 16 workshop participants (nine of whom turned in the feedback form and signed consent form) using the following prompts.

Prompts for collecting data about use of presentations by instructors

- 1) What do you want to learn and take away from today’s Dialogue?
- 2) How is oral presentation or other oral communication used in your educational setting?
- 3) When your students give oral presentations or communicate orally, what is the presentation or communication like?

Prompts for collecting data about the process of developing the rubric

1. Please list one or more strengths in the rubric-building process and explain why they add value to the rubric.

Strength of rubric-building process ...	Why this adds value to the rubric ...
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2. Please offer at least one area for improvement for the rubric-building process.

Your concern about the process ...	Suggested change ...	Actions needed ...
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3. What insights or comments do you have to offer on the rubric-building process?

After this the authors and the audience discussed some of their ideas publicly, and then the audience was asked to spend the remainder of the workshop responding to the actual content of the rubric using the format show below.

Which elements of the rubric categories would be most valuable to you? (what elements do you want to use?)

Category 1: Customizing presentation to the audience		
Most valuable elements	Why element selected	How to use/adapt for my setting?
1.		
2.		
Category 2: Interacting with audience		
Most valuable elements	Why element selected	How to use/adapt for my setting?
1.		
Etc.		

A second, very similar, workshop experience was repeated in October of 2009 at the Institute for Operations Research and Management Science (INFORMS) Education Division with approximately 25 participants (six of who turned in their feedback form and signed consent form).²¹ This was followed by feedback from a number of faculty at the authors’ campus and with selected colleagues.

In the second step of the scoring system refinement process, this feedback was utilized by the research team in carrying out a careful analysis of the content of the instrument to reduce overlap and complexity. Each of the responses collected during the process above were analyzed individually and discussed by the authors for relevance. In addition, the authors made an intentional effort to retain the basic content elements from the executive feedback. In this process, the six categories in the original rubric were reduced to four, and the number of items under those categories was reduced from 36 to 27. One item was added to the rubric that was deemed important but had not figured prominently in the executive feedback.

Third, in order to provide some idea of content validity and further refine the face validity of the instrument, the scoring system items were used by teaching assistants and the researchers to provide feedback to approximately 140 students on presentations in a senior design course. The teaching assistants were asked for their feedback about the new set of items regarding: how easily understood each item was, how effectively they were able to give feedback about the item to the students in the course, which items were most often used in student feedback and why, and which items seemed to be used only as an afterthought and why. This feedback was received continuously during the fall term, but was recorded explicitly during team meetings between the teaching assistants and the instructor at two instances: one early-on after the first use of the instrument by the TAs, and one near the end of the term.

Fourth, additional modifications and simplifications to the system were made based on the insights gained from the TA feedback process. As a result of this fourth step in the process, the current version was produced. It includes four categories (Customizing to the audience, Telling the story, Displaying key information, and Delivering the presentation) and nineteen items (for example, using concrete examples and details familiar to the audience; consistently referring to how key points fit into the big picture; using graphics which are visually appealing, easy-to-understand, and include helpful labeling; and effectively combining energy, inflection, eye contact and movement). It was also decided that the scoring system would not use individual descriptors at each of the five levels of performance in the original system, but would rather retain only the “best” description (which was renamed “wow!”). The other four categories would be rated according to what degree the “wow!” was met. See the results section below for further details.

Fifth, the resulting scoring system was applied by three raters to several videotaped student presentations to check for inter-rater reliability and evidence of construct validity. During this exercise it was discovered that (1) overall ratings for most of the items were quite consistent, (2) on several specific items, a small fraction of responses differed by exactly two levels out of five, and (3) an additional a very small fraction of responses differed by more than two levels out of five. Additional testing in the spring and summer will investigate this result more thoroughly. Prior to the annual conference in June 2010, the current scoring system will be applied to 25 videotaped student presentations. Results will be statistically analyzed for construct validity of the major system categories, inter-rater reliability, and test-retest reliability.

Results

In this section we describe the basic parts of the rubric, which will be shared in full during our presentation. We also give examples from the guidelines and supplemental materials. These will also be given to the audience in June. The four categories in the rubric are: Customizing to the audience, Telling the story, Displaying key information, and Delivering the presentation. Nineteen items are distributed among the categories, for example (1) using concrete examples and details familiar to the audience; (2) consistently referring to how key points fit into the big picture; (3) using graphics which are visually appealing, easy-to-understand, and include helpful labeling; and (4) effectively combining energy, inflection, eye contact and movement. The complete version with all of the definitions and the rating scale will be shared at the presentation.

The categories, items, and part of the definitions in the current version of the rubric are described in Table 1 below.

Table 1: Partial display of scoring system

Rater	Course					Presenter	Date
Customizing to the audience	Wow!	Yes!	Yes, but	Not much	No	Audience member characteristics are identified ahead of the presentation as observed through presentation details tailored to audience interests and needs.	
Audience connection	5	4	3	2	1	Refers directly to audience needs to help define purpose/goals of presentation	
Appropriate language	5	4	3	2	1	Describes concepts at just the right level for particular audience	
Relevant details	5	4	3	2	1	Uses concrete examples and details familiar to audience	
Taking questions	5	4	3	2	1	Adeptly accepts and satisfactorily answers audience questions	
Comments:							
Telling the story	Wow!	Yes!	Yes, but	Not much	No	Displays a logical flow and interconnectedness of the different parts of the presentation to create a memorable, unified message	
Sequencing	5	4	3	2	1	Links different parts of the presentation and uses appropriate transitions	
Key points	5	4	3	2	1	Consistently refers to how key points fit into the big picture	
Context	5	4	3	2	1	Clearly illustrates major points by linking to additional relevant information	
Sensitivity to time	5	4	3	2	1	Begins/ends on time even with questions throughout presentation	
Comments:							
Displaying key information	Wow!	Yes!	Yes, but	Not much	No	Graphics and written information enhance and reinforce the oral delivery through a focus on key points and helpful supporting information	
....							
....							

Supplementary teaching guidelines corresponding to the items in Table 1 are under development. These materials include the following supplementary information: 1) descriptions of the highest ranking score, or the “Wow” score on the rubric, and 2) information for engineering teachers about teaching students how to improve their oral presentations. For example, for item “Appropriate language” with definition “Describes concepts at just the right level for particular audience”, the teaching guidelines include “Using technical terms properly” and “Using precise communication.”

During the June presentation the complete guidelines will be shared with the audience. These materials are useful to teachers and teaching assistants in guiding the feedback process when consulting with students. Parts of the materials are shown in Table 2 below.

Tables 2a-d: Samples from Supplemental Teacher’s Guide

2a. Category: Customizing to the Audience

Item	Appropriate language
Definition	Describes concepts at just the right level for particular audience
“Wow” Description	Concepts are rephrased or simplified as needed to suit audience background Clearly defines and explains the use of important technical terms without additional complexity
Teaching Guidelines	<p>Technical terms used properly:</p> <ul style="list-style-type: none"> ---Avoid ambiguous or nebulous terms such as “optimal” ---Acronyms used only with explanations: Use of acronyms or abbreviations: If technical audience, can use acronyms or abbreviations once with explanation and then use acronym or abbreviation by itself. If non-technical or mixed audience, do not ask audience to learn and remember new acronyms and abbreviations. Instead, spell out the phrase each time. (general principal: Presenter goes extra step so audience doesn’t have to work to understand message.) <p>Communication is precise</p> <ul style="list-style-type: none"> --avoid excessive or unnecessary words ---Avoid slang such as “stuff,” “you guys,” instead use professional language ---Use appropriate grammar and spelling: all spelling and grammar is correct; capitalization is consistent; periods are included in all sentences in examples and demos, but not on phrases. To check slides for typos, read your slides, very slowly and carefully, aloud.

2b. Category: Telling the Story

Item	Sequencing
Definition	Links different parts of the presentation and uses appropriate transitions
“Wow” Description	Relates the story of the presentation in a memorable way, using transitional language between key points that logically show how they lead to each new topic Reviews the relationship between points already made
Teaching Guidelines	<ul style="list-style-type: none"> ---For transitioning from speaker to speaker: Two ways to transition: <ol style="list-style-type: none"> 1. Strong transition sentence "And now XXX will be talking about the deliverables..." Note: volume of voice stays strong throughout transition 2. One speaker finishes and steps down and next speaker starts ---Similar content is placed together in the presentation ---Presenter does not speak on a subject without explaining it first ---Audience not confused by presentation ---In Communication Lab instruction, use storyboarding to check logical flow of a draft presentation or to create a new presentation. (In storyboarding, a practice adopted from the film industry and revised, students write the title of each slide on a page of empty boxes, in left to right order. Then they answer a series of questions to help them check for logical flow (see storyboarding materials) ---Slides include overview (or executive summary), introduction (background to acquaint audience with specific situation), main content (for example, examples; model), summary (including no new information) OR conclusion, and next steps or future steps slides (when one point of the presentation is to continue discussion and make sure presenter is on same page as audience, e.g. client presentations) Etc.

2c. Category: Displaying Key Information

Item	Layout and Design
Definition	Information is easily understood due to layout, and color is used appropriately
“Wow” Description	Regularly includes on the slide: data needed to support key points and b) cues for audience to topics of explanation necessary for audience to understand the key points Slides consistently include enough information of different types to engage the audience around the key points Information on slides consistently avoids distracting the audience from the key message
Teaching Guidelines	<u>---Use minimal animation---</u> be sure not to distract audience from message. Having chunks of text show up on the slide one at a time may enhance audience understanding. But often, having text fly in from the two sides ***use better wording here*** or having text crystallize while audience waits to be able to read it will distract the audience from your message. ---Know the size of the room where you will present before your presentation, and check to make sure all information on the slides is viewable from back of room <u>---Use color or variation in font boldness</u> to show differing emphasis on pieces of information. When using color, 1) make sure background color doesn’t interfere with message, 2) use color to indicate the most critical information, 3) use red sparingly because it’s the color of emergency, and 4) do not have a large number of different colors on a page if it interferes with the message

2d. Category: Delivering the Presentation

Item	Personal Presence
Definition	Effectively combines energy, inflection, eye contact, and movement
“Wow” Description	Effectively combines energy, inflection and eye contact to engage the audience throughout presentation Uses hands for emphasis but avoids too much body motion and nervous hand gestures Knows the material well without memorizing it
Teaching Guidelines	<u>Energy:</u> Presenters are experts on project—know project better than anyone else. Make sure to be strong and enthusiastic in your knowledge but open to audience’s ideas and questions. ---Demonstrate an interest in your message even though you are very familiar with it by the time you present. ---Be definite about information <u>Inflection:</u> avoid monotone; use inflection to keep audience interest ---Avoid memorization of presentation by changing your words slightly every time you practice the talk. Focus on using slides as cues and remembering main points and how they fit into big picture. Avoid memorization so if you are interrupted with a question or other interruption you will not lose your place and need to back up several sentences or use a very long pause to relocate your prior points. ---Memorization is interpreted to the audience as lack of respect because you are not really actively looking for their input and taking it into account; you are focused only on your own words. <u>Eye contact:</u> AVOID USING NOTES because audience interprets this as lack of respect (you didn’t even take enough time to prepare to deliver your message to them) ---If need to, when starting, look at audience’s foreheads or between brows ---If not ready to survey whole room, focus on 2 or 3 members of audience, for starters ---Avoid talking only to person with highest authority ---Excellent eye contact is used to touch base with all of your audience, checking nonverbal cues for misunderstanding, negative reactions, or boredom

	<p>Movement: avoid overuse of hands, which is distracting. Use hands selectively, naturally and confidently to underscore main points in message.</p> <p>---Avoid other distracting gestures (such as swaying from foot to foot, flipping hair, and playing with change in pocket) so audience can clearly receive your message</p>
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These tables represent part of the supplemental teaching guidelines; the full document will be shared at the conference. The scoring rubric by itself is useful for grading engineering student presentations. These supplemental guidelines provide specific information for instructors to use when helping their students improve their presentation performance.

Conclusions and Implications

Many different rubrics are now used for grading engineering student oral presentations. However, none have been based on the input of executives who used to be engineers and who now, as business success stories, are hiring many new engineers. In addition, to our knowledge a description of the process of building such a rubric does not appear in the literature. In this paper, we first provided a detailed description of how our rubric was built so others will have a resource for building one of their own. Second, we have shared part of the engineering oral presentation rubric we created based on executive input. The full version will be shared at the conference. The resulting tool has high face validity: it clearly reflects real world oral communication. The tool also has high content validity: it is drawn from engineers already very successful in communicating in the workplace. Third, we have described the supplemental teaching guidelines that define the rubric items in more detail and provide information on how to help students improve their oral presentation skills. Many engineering faculty would like to include presentation skills in their courses. Often they and their teaching assistants recognize the needed skills without necessarily knowing how to articulate the implications of the skills or how to use them in instruction. The rubric and the supplemental teaching guidelines will help them grade students' presentations and teach the students how to improve. We designed these tools with the expectation that they will be useful by faculty or teaching assistants, in varying engineering subject areas, and in varying types of institutions.

In the near future we will continue the testing of the tools, first focusing on the application of the tools by teaching assistants. We plan to evaluate the tools' effectiveness by using them to assess student presentation performance in undergraduate engineering courses. As a next step, we hope to integrate these instructional tools with the software system called Calibrated Peer Review.²³ This system was developed at UCLA, is currently in use at about 100 institutions for writing instruction, and is now under development for use with presentations at Louisiana State University.²⁴

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