

AC 2008-2847: COMMUNICATION INSTRUCTION IN AN ENGINEERING INTRODUCTORY STATISTICS COURSE

Judith Norback, Georgia Institute of Technology

Dr. Judith Norback is the Director of Workplace and Academic Communication in Georgia Tech's Stewart School of Industrial and Systems Engineering. She received her B.A. magna cum laude from Cornell University and her Masters and Ph.D. from Princeton. Before joining Georgia Tech in 2000, she taught at Rutgers University, worked in job-related basic skills research at Educational Testing Service, and then founded and directed the Center for Skills Enhancement, Inc. Her research and curriculum development interests lie in workforce communication skills needed by undergraduate engineering students. At Georgia Tech, she conducts and coordinates workplace interviews and teaches communication skills to undergraduates. Her research has been supported by the Sloan Foundation and the National Science Foundation. She has published in IEEE Transactions on Professional Communication.

Nicoleta Serban, Georgia Institute of Technology

Dr. Nicoleta Serban is an Assistant Professor at Georgia Tech's Stewart School of Industrial and Systems Engineering. Before joining Georgia Tech in 2005, she received a B.S. in Mathematics and an M.S. in Theoretical Statistics and Stochastic Processes from the University of Bucharest. Her doctoral degree in Statistics is from Carnegie Mellon. Serban conducts research in statistics and teaches courses such as undergraduate Basic Statistical Methods and graduate Time Series Analysis and Spatial Statistics. Her main research areas are in nonparametric statistics with a focus in multiple functional data analysis and spatial statistics. Dr. Serban has published in the Journal of the American Statistical Association, Biometrics and Journal of Statistical Inference and Planning.

Nagi Gebraeel, Georgia Institute of Technology

Nagi Gebraeel is an Assistant Professor in Georgia Tech's Stewart School of Industrial and Systems Engineering. He received his MS and PhD from Purdue University and he holds a B.Sc. in Production Engineering from the University of Alexandria, Egypt. Dr. Gebraeel teaches Basic Statistical Methods and other courses. His research focuses on improving the accuracy of predicting unexpected failures of engineering systems by leveraging sensor-based data streams. His major research interests are in the areas of degradation modeling and sensor-based prognostics, reliability engineering, sensor-driven maintenance operations and logistics. Dr. Gebraeel's research has been funded by the National Science Foundation, Department of Defense, and industry.

Garlie Forehand, Georgia Institute of Technology

Garlie A. Forehand is now a consultant in educational design and assessment. He received his Ph.D. in psychometrics from the University of Illinois and his B.A. in psychology from the University of Richmond. Forehand has held academic and research positions at the University of Chicago and Carnegie Mellon University. For the past 20 years, one of his areas of research and curriculum development has been workforce communication skills and instruction for undergraduates in engineering.

Communication Instruction in an Engineering Introductory Statistics Course

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Abstract

At Georgia Tech, instruction in communication has been incorporated into the introductory statistics class for undergraduate engineers. Communication instruction focuses on presentations to workforce professionals—clients, executives, and engineers. The communication instruction is based on interviews conducted with engineers, supervisors, and senior executives whose companies employ many engineers. Students worked in small project teams to formulate hypotheses about a set of data and to select the appropriate statistical method to evaluate the data. Student teams presented their projects at the end of the semester. In preparation for project presentation, students received workforce presentation instruction in class and in a Workforce Communication Lab set up for video review, storyboarding, presentation practice, and feedback. Assessment data focuses on student needs expressed prior to instruction and benefits described after instruction, and the value of instructional components. Examples of projects and instructional materials will be provided so the instruction can be replicated at other institutions.

Introduction

Over the past decade, multiple studies have indicated the need for better communication skills for engineers^[1-5]. Studies have also identified, more specifically, the importance of oral presentation skills to the advancement of engineers in the workplace^[6,7]. As recently as 2007, students' definitions of excellence in engineering education included communication skills^[8].

In 2004, one study reported that, of 73 top-ranked U.S. and Canadian engineering schools surveyed about communication instruction for engineers, 33 percent reported integrating instruction “in which communication specialists and engineering professors collaborate^[9]. Many schools have integrated the instruction with various engineering courses, particularly the Capstone Design course^[10-16].

Student projects and communication skills instruction have already become a part of some introductory statistics courses. Projects have been included for a long time^[17-20], even as far back as the 1970's^[21]. Some statistics professors have recently stressed the importance of communication skills to statistics undergraduates. In 2002, in a summary of six papers presented in a symposium focused on the importance of undergraduate statistics education (“Improving the Work Force of the Future: Opportunities in Undergraduate Statistics Education,”) one author wrote “the ability to communicate effectively is as important to the success of a bachelor's level statistician as knowledge of the principle statistical methods in a field.”^[22]. In some universities professors have added an oral communication component to their course for undergraduates^[e.g.,23]. Others have added similar instruction to graduate statistics courses^[24].

In this study, communication instruction focused on presentation skills was integrated into the Stewart School of ISyE at Georgia Tech Basic Statistical Methods course as a pilot project in 2006^[25] and then during the Fall of 2007. This paper focuses on the results from 2007. To the best of our knowledge, the approach is unique in the following ways:

- 1) The instruction is based on workforce input. Engineers, managers, and senior executives have been interviewed to see what communication skills new engineers need to be job competitive and to quickly ascend the career ladder.
- 2) The instruction involves repeated practice of oral presentation skills.
- 3) A communication specialist (the Director of Workforce and Academic Communication) and a statistics professor work together to provide the instruction.

The approach is described in more detail below.

Approach

The basis of the presentation instruction is unique in its stress on information about communication collected directly from people in the workforce: practicing industrial engineers, managers, and senior executives of organizations employing many industrial engineers. The interview process is described in detail elsewhere ^[15,16]. The instruction is referred to as *workforce presentation instruction* because it focuses on a subset of the skills identified through the interviews. These presentation skills were shown to be central to graduates' job competitiveness and quick move up the career ladder. The skills included in the instruction are shown in Table 1.

Table 1. Workforce Presentation Skills included in Basic Statistical Methods Instruction

Content	1. Message is presented in a logical, organized, easy-to-follow sequence.
	2. Message is presented in essential format (including a description of the project, the exploratory data analyses, the methodology and the results).
	3. Charts and graphs, if used, are relevant, clear and understandable.
Delivery: Stays Professional	4. Slides and speech are free of grammatical and spelling errors.
	5. Slides are free of distractions.
	6. Important information is emphasized in slides (for example, through the use of color or font.)
	7. Speaker concisely presents message.
	8. Speaker uses effective speaking style (that is, good volume and pace, free of "ums," proper inflection).
	9. Speaker introduces next speaker.
Delivery: Keeps the Audience's Attention	10. Speaker maintains good eye contact.
	11. Speaker responds appropriately to audience questions.

The second characteristic of the workforce presentation instruction is repeated practice. Students practice presenting both before their presentation to class and then after their presentation to

class (in order to better prepare them for presentations they will give in the future.) The practice takes place in a Workforce Communication Lab ^[18], an area with six presentation stations set aside for this purpose. In the practice sessions, feedback is provided live by the Director of Workforce and Academic Communication and her teaching assistants. In the “before-presentation” practice session, students practice presenting, receive feedback, and then practice again. In the “after-presentation” session, feedback is provided through viewing the videotape of the class presentation. Then the students practice and get feedback. The details of the instruction are described below.

Description of the Workforce Presentation Instruction

Examples of the student project topics are:

- 1) Does the ratio of various colors in M&Ms match the information provided by the manufacturer?
- 2) In professional baseball, is the number of home runs related to the number of steals?
- 3) In professional basketball, is a strong defense related to success?
- 4) Are CEO salaries related to their age?
- 5) Do more traffic accidents happen on Friday the 13th, as the superstition claims?

The four components of the instruction are 1) an overview of the skills to be taught, providing a grounding for the rest of the instruction; 2) Lab experience: practice and feedback before the class presentation, 3) videotaping during the class presentation, and 4) Lab experience: video review, feedback and practice after class presentations. All four parts of the curriculum are mandatory. Table 2 includes specific details of the instruction. A teachers’ guide for teaching the skills will be distributed at the conference and is available on www.isye.gatech.edu/workforcecom.

Table 2. Components of Workforce Presentation Instruction

Component	Description
Overview during class	Review description of 11 skills and give tips for performing well on the skills
Preparation for presentation in Lab	Storyboarding (to correct any issues with logical flow), discussion of slide characteristics; presentation practice, feedback, targeted practice
Class presentation	Each presentation is videotaped; Director of Workforce Communication notes feedback on 11 skills
Feedback after class presentation	Viewing of videotape and review of Director of Workforce Communication’s feedback; targeted practice and feedback

Evaluation

This evaluation focuses on student input. Before communication instruction, students contributed information about their instructional needs. After instruction, the same students again gave self-assessments, reported on the help they received, and evaluated components of the instruction.

Instructional Needs

At the beginning of the class, 98 percent of the students reported that they would like to improve their presentation skills. They provided more detail about help they felt they needed by responding to a list of 11 skills. The skills, expressed as desired communication characteristics, are among those needed for workforce communication according to senior executives and engineers in the workplace ^[15,16].

The responses are presented in Table 3. Each of the 11 skills was identified as a need by a substantial number of students. The presentation skills the students felt they most needed were “using effective speaking style” (skill 7) at 93 percent; “responding effectively to questions” (skill 11) at 87 percent; “presenting the message concisely” (skill 10) at 85 percent, and “presenting the message clearly and in a logical sequence” (skill 1), also at 85 percent. The lowest rated skill was “slides and speech are free of grammatical and spelling errors” (skill 5), at 51 percent. Students started by recognizing their own need for improvement in presentation skills.

Table 3. Student Reports of Communication Needs and Help Received

		Need help (pre) (percent)	N	Received help (post) (percent)	N
1	Message is presented clearly and in a logical, organized, easy to follow sequence.	85	40	85	41
2	Message is presented in essential format.	72	39	90	41
3	Important information is emphasized in slides.	67	39	76	41
4	Charts and graphs are relevant, clear, and easy to understand.	72	39	83	41
5	Slides and speech are free of grammatical and spelling errors.	51	39	76	41
6	Slides are free of distractions.	56	39	75	40
7	Speaker uses effective speaking style, e.g., by using proper inflection, avoiding “ums,” inflection and smoothness.	93	40	71	41
8	Speaker introduces next speaker.	67	39	90	41
9	Speaker maintains good eye contact.	74	39	70	40
10	Speaker presents message concisely.	85	39	78	40
11	Speaker responds effectively to audience questions.	87	39	60	40

Help Received

At the end of the course students were asked: “Was the workforce communication useful?” Ninety percent (N=40) answered “yes.” Further analysis explored the skills that were most improved.

At the end of the course, students were presented with the same list of 11 skills that they used to express instructional needs. At the end of the course, they were asked which skills the workforce presentation instruction had helped them with.

The post-instruction responses are presented in Table 3. Substantial proportions of students reported that they had received help in all of the skills. Seventy percent or more reported receiving help on all of the skills except skill 11, “responding effectively to audience questions,” at 60 percent. The most frequently chosen skills were presenting in essential format (skill 2) at 90 percent; introducing the next speaker (skill 8), also at 90 percent; presenting in a clear and logical sequence (skill 1) at 85 percent, and use of charts that are clear and easy to understand (skill 4) at 83 percent.

Effectiveness of Course Components

At the end of the course, 98 percent (N=39) of the students reported the communication curriculum was useful. Ninety-one percent (N=44) said they thought “Introduction to Statistics is a good place to practice and learn these presentation skills.”

Students also rated the effectiveness of three course components: in-class tutorials; feedback on presentations in the Communication lab before the presentation; and feedback after the presentation. It can be seen from Table 4 that all components were perceived to have value by substantial proportions of students. The components most highly valued were feedback in the Communication lab, both before and after the class presentations.

Table 4. Student Evaluation of Future Curriculum Components

Curriculum Component	percent Responding				Mean
	Of Little Value (1)	Somewhat Valuable (2)	Very Valuable (3)	Extremely Valuable (4)	
In-class tutorial	8	51	19	0	2.4
Presentation feedback in Communication lab <i>before</i> class presentations	2	15	46	37	3.2
Presentation feedback in Communication lab <i>after</i> class presentations	0	25	35	40	3.2

Student comments:

Many students answered the three questions, “*In what ways was the workforce presentation instruction useful?*” 2) “Is there anything else you would suggest changing?” and 3) “Any additional comments?” The answers represented four themes: professionalism, awareness of good communication skills, comments about skills, and appreciation. Some of the answers are included below.

- 1) Professionalism---for example, students said
 - a. “It [the instruction] helped to gather a sense of professionalism.”
 - b. “I like this program! I think it will definitely help students with senior design, other campus presentations, and presentations in industry.”
- 2) Awareness of good communication skills---
 - a. “Good tips---some things you may not have known/realized”
 - b. “Notice small things, I wouldn’t normally see”
- 3) Comments about skills---First, information display...then more general comments---
 - a. “Fixed our slides to display information effectively”
 - b. “Slide layout, proper way to display statistics”
 - c. “Helped to organize our thoughts into concise slides, etc.”
 - d. “I got to learn what to do and what not to do in a presentation.”
 - e. “constructive criticism”
 - f. “showed us the video, which helped us see our mistakes”
 - g. “Videotape showed flaws and strengths. TAs’ advice proved essential to our success.”
 - h. “helped me see that my presentation reality was different than I imagined”
- 4) Appreciation---
 - a. “I think this is a very useful tool for all IEs.”
 - b. “The individual group help was wonderful!”
 - c. “very helpful”

As mentioned earlier, the instructional materials used in this introductory statistics course are on www.isye.gatech.edu/workforcecom. A teacher’s guide is available as well.

Discussion

Instruction in presentation skills was built into the introductory statistics course at the Georgia Tech Stewart School of Industrial and Systems Engineering with the intention of improving the workforce communication of the students.

Students felt it was appropriate to include the instruction in an introductory statistics class. They started by recognizing their own need for improvement in presentation skills. Then, after receiving instruction in workforce presentation skills, they reported receiving help in a substantial number of the presentation skills. For some of the skills, fewer students reported

getting help with a skill than indicated that they needed help and instruction on the skill. For example, 87 percent of students indicated they needed help with responding effectively to audience questions. But 60 percent thought they received help with the skill. This information is being used as formative feedback for future semesters. For example, more information is now being collected as part of the instruction: during each Lab visit, notes are made regarding the exact skills practiced. Answering audience questions will receive more emphasis in the instruction in the future.

All the components of the instruction were perceived to have value by substantial proportions of students. The positive nature of the students' response indicates benefits to other universities' implementation of similar instruction.

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