ABET 2000 Criteria 3g and the Meaning of Communication

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Abstract

This paper reports part of the findings from a larger research study on the ways in which the field of engineering education "talks" about communication. The goals of the research study are 1) to analyze the uses and meanings of "communication" exhibited by peer reviewed papers in engineering education publications from the year 2000; 2) to analyze how the authors interpret ABET 2000 Criteria 3g: "to be effective communicators;" and 3) to identify specific areas for further investigation regarding communication and engineering education. We examined the *Journal of Engineering Education* for articles published in 2000 that dealt with the concept "communication" and the Best Paper Award nominees from the 1999 Frontiers in Education Conference. After distinguishing between authors' use of the word communication to refer the act of exchanging meaning versus the tools for such exchange acts, we consider each paper using a taxonomy of communication characteristics, including mode (visual, oral, or written), formality, and mediation. Our primary finding is that most papers consider only two forms: informal oral communication or written formal communication. Therefore, there are major research opportunities for engineering educators to consider other forms of communication, their existence in the classroom, and their effects on learning. In this paper we describe the study and report the findings for oral and visual communication.

I. Introduction

Why is communication important in engineering?

The importance of communication in engineering seems so patently obvious, that its discussion may appear frivolous. After all, no design of a new product or process would have an effect if the engineer can not describe it well enough that others understand it. Yet, who are the others who must understand the design? How does an engineer influence the decision makers and resource controllers? In the 21st century, the others with whom the engineer must communicate have a wide variety of technical expertise, may have a different set of evidence which persuades them, and may have a different set of expectations regarding how communication should occur. Thus, the 'universal' language of mathematics and schematic drawings is no longer a sufficient language for engineers to know and use fluently.

In addition, numerous surveys of industry during the 1990s explicitly list communication skills of engineering graduates as needing improvement.[1-3] In response, the ABET 2000 criteria state that a program must demonstrate that its graduates have "an ability to communicate

effectively".[4] Engineering faculty members have been thrust into the situation of teaching and evaluating communication skills, even though they may not be confident of their own skills. Not surprisingly, many are finding this more difficult than teaching and evaluating technical content. Fortunately, on many campuses, communication faculty have joined with engineering faculty to design courses, activities, and processes for teaching and evaluating communication skills. Additionally, conferences such as Frontiers in Education and the Annual Conference of the American Society for Engineering Education as well as journals such as the *Journal of Engineering Education* and the *Journal of Professional Issues in Engineering Education and Practice* have published several papers attempting to help engineering faculty teach communication skills. The prevalence of these separate efforts underscores the importance of this issue to the community of engineering educators.

What do we mean by the word?

Despite our agreement on its importance, it is not obvious what we, as engineering educators, mean by 'communication.' Webster defines 'communicate' as 1: to make known, disclose; 2: to transmit, as a disease; or 3: to have an exchange, as of ideas. 'Communication' is then defined as 1: the act of communicating; or 2: the exchange of ideas, messages, or information.[5] Therefore, the denotative meaning of the word allows both a one-way transmittal, as in to disclose, and a two-way exchange of meaning. Thus both straight lecture and Socratic teaching would be considered methods of communicating.

Sociolinguists, however, have a more complex view of communication. Conversation, and by extension communication, is a joint production: Everything that happens is the doing of all participants.[6] Hence, communication is not the act of an individual, but is a socially constructed event with each individual using their communicative competence – the knowledge that a speaker has at their disposal to determine what they can expect to hear and to contribute in a discourse, in terms of implicitly internalized assumptions in the discourse community with respect to the context at hand. Although there is no need, from a disciplinary perspective, for every engineering educator to engage in a sociolinguistic analysis of engineering communication, it is important to realize that such work is possible and is being done, albeit slowly in the context of engineering education. This work can form a foundation for more rigorous work in engineering communication.

Within the engineering education community, what do we mean by 'an ability to communicate effectively?' That is one of the goals of this research project – to analyze the uses and meanings of 'communication' within the engineering educational community. In addition, we consider the question of where are engineering faculty focusing their efforts in terms of teaching and evaluating communication? When these questions are answered, we can then consider what is being left out. What meanings of the word and types of communicative competencies are not being addressed? Finally, we contemplate the question of how we can incorporate the theory of discourse communities. This research project is too broad in scope to report in one paper. Hence, for this paper, we will focus on the findings that relate to oral and visual communication.

II. Methodology

Where do engineering educators exhibit their understanding of communication?

In order to answer our questions, we must first determine where and how engineering educators exhibit their understanding of communication. The most thorough way to describe what the discipline believes is to carefully document what it does. However, an observational study of multiple faculty and students over time in various contexts which notes all the different instances of the use and meaning of communication is impractical, inefficient, and unwarranted. Instead, we decided to begin with observing how engineering educators exhibited the concept of teaching and evaluating communication in their journal articles. Articles have the advantage of being stable text, of being intentionally written to be clear, and of being validated in some sense through peer review. Since our study is limited to the United States engineering educational community, we chose the *Journal of Engineering Education (JEE)* as being the journal that was widely read and contributed to by a large cross-section of the community. We limited our review to articles and educational briefs published in the year 2000, believing that a continuous time segment would give the best sample of papers. Each title and abstract was carefully read to determine whether communication was mentioned or was likely to appear in the paper. If it was, the whole paper was carefully read and analyzed. If the title and abstract gave no indication that the paper should be included, then the paper was skimmed to pick up any use of the idea of communication.

In addition to journal articles, we included the 1999 Frontiers in Education Conference Best Papers, which were published in JEE in 2001. We included these papers to add the representation of conferences to the data set. Although this set of papers was small, it added the potential to find additional understanding of communication by authors who are considered by their peers to be on the 'frontier.'

These two sources provided 76 papers to consider. Using these decision rules, we selected 30 papers that qualified for the study. Therefore 39% of the papers included communication as a topic or theme.

What data do the papers contain?

The unit of analysis in this study is the individual paper. We collected both quantitative and qualitative data from each paper. For each paper that was included in the analysis set, we first abstracted all references to communication, either specific or general, and the surrounding context (usually the sentence or paragraph) into a text file. Next, we coded the references according to our taxonomy described in the next section and classified the paper as having communication as a major or minor focus. Finally, we considered the paper holistically to discern the author's implied definition and treatment of communication. This last step is an important part of investigating both the explicit and implicit understanding and use of communication within engineering education. Also, viewing the writing and reading of a journal article as a communicative process, both the author and the reader bring their own communicative competences to the interaction. Sociolinguistic theory tells us that these implicit knowledge bases vitally impact the exchange of ideas. Therefore they should not be ignored.

What characteristics of communication are most salient for answering out research questions?

Rather than using a standard taxonomy of communication, the authors developed their own based on their experiences as an engineering educator and a cultural anthropologist. Therefore, the taxonomy is simple, focused on the features that are most salient for the current research questions, and are defined in the context of engineering communication.

The first characteristic in the taxonomy is the mode of communication: written, verbal, or visual. The guiding definitions for coding the text incidences are:

Written: using language in a form that is not spoken, but is written, typed, or electronically stored as text (does not include sound files).

Oral: using spoken language, which may be in real-time or may be stored and heard later.

Visual: using non-alphabetic language to convey a message, e.g. drawing, picture, graph, symbols, etc.

This characteristic is categorical and not disjoint, that is, a particular text passage may be coded as more than one category (for example, a client presentation may include both a written report and an oral presentation).

The second characteristic is a dichotomous designation of formality. Formality considers whether the communicative event is rehearsed or prepared in advance and considers the risk involved to the one in the less powerful position. For example, a final design report is considered formal because it should be written in advance, edited, and rewritten, and because it carries a high risk for the student submitting it. If the audience (the professor) does not understand the meaning the author (the student) intended, then a bad outcome (failing the course) is likely. On the other hand, a flurry of email messages between students in the middle of the night as they draft and edit the report is coded as informal. The email messages themselves are usually not practiced or rehearsed, but are composed spontaneously. If the audience does not understand the meaning intended, they have an easy opportunity to ask for clarification. Since the students share the same power position, there is lower risk to the writer of the email than the risk associated with the formal report submission. Although in engineering practice, the characteristic of formality is a continuous one that is based on many different characteristics of the context and circumstances of the communicative exchange; in this study, coding the text as being formal or informal was usually straightforward.

The third characteristic is the type of mediation used in the communication. Mediation concerns the medium used for communication and the availability of non-verbal cues. The coding for this characteristic designates the communication as being face-to-face, computer, or paper. Face-to-face communication implies the people are in the same geographical space and that non-verbal cues such as facial expression and body language are available to add meaning to the interaction. The designation of paper mediation implies that written and visual language are being used on paper, therefore not only are non-verbal cues not available, but cues in the tone and pacing of oral language are also not available. The category of computer mediation is, in some sense, in between face-to-face and paper mediation. Since a computer (or similar device) is being used, the people are geographically dispersed. However, the use of real-time video or audio may make some non-verbal cues available; although their usefulness as a source of information about the speaker's meaning may be reduced. The computer category has the interesting feature of being dependent on the technology which is used. If the computer

mediation is email, for example, then its primary advantage over postal mail is the short time it usually takes for a message to be delivered. However, taking a 'Star Trek' visionary perspective, one can imagine holographic projections of the participants in real-time, making the mediated communication amazingly close to face-to-face.

III. Observations and Interpretations

Quantitative Data Analysis

We first report the quantitative data analysis which investigates the prevalence of different modes and formalities of communication. Each paper was classified as including or not including each of the six categories resulting from mode crossed with formality. In addition to reporting those numbers, we report the number of papers which included both formalities within a mode and either or both. Table 1 gives the count data and the percentage those papers that included communication as a topic or theme (n = 30). Table 2 reports the counts and percentages considering only the papers that had communication as a major focus or theme (n = 12).

Table 1: Counts and Percentages Based on Papers with Major or Minor Focus (n = 30)

	Written	Oral	Visual
Formal	24 (80%)	14 (47%)	7 (23%)
Informal	10 (33%)	20 (67%)	6 (20%)
Both	9 (30%)	10 (33%)	4 (13%)
Either or Both	25 (83%)	24 (80%)	9 (30%)

Table 2: Counts and Percentages Based on Papers with Major Focus only (n = 12)

	Written	Oral	Visual
Formal	7 (58%)	5 (42%)	2 (17%)
Informal	4 (33%)	7 (58%)	1 (8%)
Both	3 (25%)	3 (25%)	1 (8%)
Either or Both	8 (67%)	9 (75%)	2 (17%)

The first observation we make is that 30 of 76 papers (39%) that were published in JEE in 2000 or 1999 FIE Best Paper Award nominees included at least a minor focus on some kind of communication. Hence, communication is an important aspect of engineering education. Furthermore, nearly 1/3 of these papers included written communication and nearly 1/3 included oral communication. However, only 12% included visual communication. Perhaps this indicates a research opportunity to explore the visual exchange of ideas from a different perspective than the traditional approach which considers graphics a skill or competency of the individual.

Secondly, when we restrict our attention to those papers that have a major or minor focus on communication in Table 1, two areas jump out as being most prevalent: formal written communication and informal oral communication. We were surprised at how many papers included informal oral communication, sometimes discussed as team dynamics or interactions. Two of the papers focused exclusively on informal oral communication among teams and will be discussed in more detail below. Again, visual communication received the least attention. All but one of the papers that included informal written communication also included formal written

communication. In contrast, only half of the papers that included informal oral communication also included formal oral communication. These statistics reflect our experience that students are more often asked to submit formal reports and to work in teams than to write informally and to give formal speeches.

Considering only those papers with a major focus on communication gives a slightly different picture in Table 2. The differences in percentages are smaller, with formal and informal designations not as distinct within each mode of communication. In addition the focus on formal written communication is less within this subgroup of papers. Again visual communication is treated by a smaller percentage of papers. This analysis shows us that the emphasis in articles is on fromal written and both formal and informal oral communication. The visual mode of communication is wide open for investigation as is the interplay between formal and informal types and the interplay among the three modes. Now that we have an understanding for the prevalence of different modes and formalities, let us focus on the qualitative data analysis of oral communication and then on visual communication.

Oral Communication

Oral communication in these papers easily disaggregates into formal oral communication (that is, giving speeches) and informal oral communication (that is, team work, team dynamics, group interactions, etc.). Although several of the papers consider formal presentations of team projects, the authors do not address the intersection of informal communication and formal presentations; that is, we do not know whether the professors require that each team member participate in giving a part of the speech or whether the team is permitted to select a spokesperson. In our experience, general engineering educational practice usually requires each student on the team to participate in the group's presentation. The influence of informal team dynamics on formal team presentations is an area that has not yet been researched. We will now consider the findings from analyzing the discussions of formal oral communication and then we will turn to informal oral communication.

The authors give a variety of purposes for including presentations in the engineering curriculum. The most common one is to give the students practice and respond to industry's and ABET's call for improved communication skills in engineering graduates. The second common reason is the argument that preparing a speech helps students learn to organize their thoughts and better convey information. One particularly interesting paper advocates requiring a speech on one's work after the draft of the written report is completed, but before it is finalized. This author convincingly argued that the final report is more complete because the student can respond to the audience's questions and remarks. (Note: This is similar to the practice of giving a work-in-progress talk at a conference before writing a journal article.)

The formats for presentations covered by the papers varied widely in terms of the audience, including speaking to real clients or mock clients (professors), giving poster sessions open to the whole university and industrial communities, presentations to classmates only, and critical design reviews. The discussions of evaluating the presentations focused on the need for organization, the clarity of presentation, and displaying mastery of the technical content. The specific type of speeches were limited to conveying technical information and persuading an audience. Not surprisingly, there was no mention of speaking to inspire, to entertain, or to share

life experiences. What was surprising however, was that no author discussed the idea that different audiences (professors, clients, other engineering teams, etc.) may be swayed by different types of evidence. Including this aspect of formal oral communication in the engineering curriculum may help address industry's concerns that engineering graduates are not business savy. Although spending the majority of a presentation on a bridge design explaining the technical details of stress and strain may be appropriate for a class presentation in statics, it would not be appropriate at a city council meeting.

The final observation on formal oral communication we made was that all of the authors seem to assume that participation implies improvement; that is, that doing a speech improves one's communication skills. None of the authors offered any evidence that students' oral communication skills actually improved. There are many viable reasons for this, including the limits of space in the article, the difficulty in measuring improvement in communication, and the choice not to focus on that aspect in the research. However, it may also be that when it comes to communication skills, as a group faculty accept the adage "practice makes more nearly perfect" without question. As the new ABET 2000 criteria become more familiar perhaps some engineering educators will turn their efforts to developing a comprehensive set of outcome measures and evaluation mechanisms for students' formal oral communication skills which can then be used to defend or refute this conventional wisdom.

Regarding informal oral communication, we were surprised at how many papers addressed it at least obliquely as team dynamics. As reported above, 20 out of 30 papers included some discussion of it. Two of the papers focused exclusively on research studies of team dynamics, so we will discuss those individually and then report the analysis of the remaining 18 papers.

Natishan, Schmidt, and Mead[7] report the results of student focus groups which explored team project class experiences. In student focus groups with trained student facilitators, students reported their experiences narratively and gave a holistic view of their experiences, which may have been supported with specific examples. This method's weakness is that the findings can not be correlated directly with particular courses or teaching methods, but its strengths are that students themselves assign meaning to experiences rather than the researchers, the data are rich qualitative narratives rather than categorical data, and the focus group facilitators have the opportunity to follow-up on a particularly interesting comment. One of the question sets that facilitators posed to the groups was "Have you observed differences in behavior of mixed gender, ethnic, or learning style groups? If yes, what differences did you observe? Did these differences influence team performance and success? If so, how?" Their findings on the influence of gender diversity on team performance are:

> Responses from the student focus groups were divided along gender lines. Women typically responded with the sense that gender was a "big issue." They stated that in general men are naturally aggressive and tend to dominate meetings and the approach to project work whereas women are often less confident and have to be more aggressive to have their ideas heard. Women often felt they had to prove themselves before they were accepted as an equal with men in the group.

> In many cases, women believed that they were stereotyped into secretarial positions and that men did not listen to them.
>
> Men typically responded that "Politics" become a real issue when working with women. They felt that women did not have to perform certain tasks of a physical nature, which is often equated to women being lazy or lucky. They stated that women are too emotional and do not take criticism well. (p. 271)

These findings are congruent with many other studies which have found that women and men experience working in a team differently. In Felder's five semester study in Chemical Engineering, for example, he reported that women students had complaints about the cooperative learning groups during the first two semesters. An important research question is why did the complaints not show up in semesters three, four, and five? We would claim that this is a specific example of a general pattern, yet no one has collected the data to distinguish the explanation that the students learned to work together better from the explanation that the women stopped complaining because it did not result in change. Felder, for example, did not institute discussion about gender issues within groups and did not provide any additional team dynamics training in response to the students' complaints. We believe that understanding informal communication experiences are critical to understanding why there are not more women in engineering.

Haller, Gallagher, Weldon, and Felder[8] took a different approach to studying a specific aspect of informal oral communication. They focused on the interactional dynamics among students engaged in group problem-solving sessions, using conversational analysis to identify two types of teaching interactions: transfer-of-knowledge sequences and collaborative sequences. They recorded the dialogue of one problem-solving session of each of four teams of students. The only demographic information given about the teams were the gender compositions, which included all possibilities except more males than females. In this research design, the researchers coded the students' dialogue and interpreted the meaning of it. The students apparently were not asked to respond to the researcher's interpretations. In addition to other findings, the authors report:

> While no statistical conclusions can be drawn from such a small sample of dialogue, the fact that the all-female group engaged in the highest percentage of CSs (collaborative sequences) is consistent with other sociolinguistic research on gender and language, which indicates that women prefer collaborative floors (in which speaker turns overlap and participants contribute simultaneously to the ongoing interaction) to competitive floors (in which turns are taken one at a time with participants competing for turns). … Further research with a greater number of interactional samples is needed, however, to reliably determine effects of gender and gender mix on teaching sequence styles. (p. 288)

The findings of these two papers reinforce the perspective of most cooperative learning experts that gender composition within a group is a critical issue and one woman should never be alone in a group. In addition, these papers point to the need for more research on exactly how communication and team work is affected by gender composition and conversely how experience in groups of different compositions affect the students.

Qualitative analysis of the remaining papers reveals two important and related observations. First, several authors claim that participation in group discussion or team activities will improve students' communication skills without giving any evidence to support that claim. For example, one set of authors write "The group portion of [a given testing activity] promotes team work and the students' communication and interpersonal skills, including taking into account cultural differences." Another set of authors state "Students will be encouraged to become active learners and improve their communication skills through required participation in regular in-class activities and discussions." Although it may seem reasonable to expect such outcomes, much of the research on communication in groups suggests otherwise. (See for example, Tannen, Talking from 9 to 5, 1994).

A second and related observation is that several papers include mention of 'problems with team dynamics' yet none of the papers goes beyond mentioning it. To us, this might imply an implicit agreement among engineering faculty that student teams are going to experience communication problems; however, there is no explicit discussion of the responsibilities of the faculty to respond to this issue. One author in this set claims that the lack of communication among team members is easy to spot and to correct through intervening with the group. However, we believe group dynamics and communication patterns are much more resistant to change than this author implies. Furthermore, we believe that it takes direct discussion among the team members about the value of various communication patterns and intentional practice for a group to change its initial patterns.

These observations further support the call for more research on oral communication within engineering classrooms and laboratories. The traditional methods of research in engineering education include quasi-experimental and experimental approaches using quantitative data, Likert scales, and course evaluations. However, these methods do not lend themselves to studying the detailed communication patterns and other complex human interactions among students. Therefore, the engineering education community needs to include additional researchers with the knowledge and skills required and/or needs to begin learning additional research methods to further our collective understanding.

Visual Communication

A qualitative analysis of references to visual communication leads to several observations and recommendations. First, all of the authors only reference visualizing objects; there is no mention of visualizing processes, yet many engineering activities involving designing processes as well as products. Second, if they refer to 3-D visualization, it is always using the medium of computer generated models. No authors mention using models of clay, cardboard, wood, etc. If the papers reflect the use of computer models instead of physical models, this change has implications for which learning styles are being privileged in the classroom and which ones are disadvantaged. Third, the measurement of 3-D spatial visualization skills is only done by using the Purdue test, which is a paper and pencil test of pictures of block-type objects. If a student has lots of experience manipulating LEGOs, then this test may capture their visualization skills. However, the visualization related to sewing, for example, being able to imagine the transformation of 2-D material into a 3-D piece of clothing or being able to visualize the impact of a certain combination of fabric and shapes on a quilt square, would not necessarily be captured by this test. Finally, the authors all refer to sketching and diagramming to describe what

already exists rather than to imagine what could be. This focus reminds us of learning geometry as a method of proving what one already 'knew' (such as the sum of two sides of a triangle is larger than the third side) rather than constructing new knowledge. We see visual communication as being an important way to explain to others a vision in one's mind which may not yet exist.

Given these observations, we recommend that engineering educators consider expanding their use and teaching of visual communication to include representing processes, using physical manipulables alongside graphics, and discovering new knowledge. In addition, we encourage those who do research to consider additional ways of observing, measuring, and evaluating students' development of various kinds of visualization skills.

Two important connections do not appear in this collection of articles. First, there is missing the connection between visual communication and informal oral communication in group work. Perhaps engineering could learn more about facilitating team dynamics if we researched the ways in which high functioning and low functioning teams used (or failed to use) visual communication as they worked together to accomplish their tasks. The intersection of this with learning styles and cognitive styles may also be a productive line of research. Second, although several projects mentioned including graphs, diagrams, and drawings into formal written reports, the enhancement of communication by doing this was not explored. Although students learn to produce a dazzling array of plots, graphs, and diagrams, they often do not understand how choices of scale, transformation, shading, etc. can affect the interpretations of the reader. A large body of scholarly knowledge in this arena exists and simply needs to be integrated into engineering education.

IV. Summary of Research Opportunities

In this section, we recap the research opportunities which this study has uncovered. First, in the area of formal oral communication, that is oral reports, speeches, and client presentations, the discipline of engineering educational research needs to consider how the type of evidence used to support a proposition matches the audience and how we can incorporate that idea into our teaching. We tend to assume that with formal oral communication, practice makes perfect, but we have no empirical evidence that allows us to support that assumption. Furthermore, we are unclear as to what kinds and how much practice is helpful for students. Another open area for research is the influence of team dynamics on formal presentations. What kinds of team behaviors improve/inhibit successful team presentations?

Second, in the area of informal oral communication, there are many opportunities to simply describe the communication patterns among students, then to design effective interventions to improve those patterns. How do students communicate in teams? What norms or discourse rules are used? Under what circumstances? How does gender and racial composition of the team affect the communication? When and why do women report negative attitudes toward team dynamics? How does working in teams of differing gender composition affect students' attitudes toward engineering as a major, a career, and an identity? We suspect that the daily informal communication events have a tremendous impact on students' experiences.

Third, the importance of visualization skills to engineers have been espoused loudly. However, the investigation into students' abilities have been rather limited, focusing on differences in one skill that male and female students bring to college. We still need to investigate visualizing processes and how that may differ from visualizing objects. We need to learn how to teach visualization as a discovery tool, not only a representation tool. We believe that visualization may enhance communication, but how? When? Under what circumstances? What is the connection between informal visualization within teamwork and how does it intersect with oral communication? Visualization is still a wide open field for research and will become more so as the technology advances and allows more sophisticated visual communication.

Finally, there are "big picture" questions still unanswered. How do the three modes and two formalities of communication interplay? For example, how does informal oral communication affect formal team presentations? Is communication in engineering practice different from communication in engineering education? Do students communication styles and norms change over time? How can we assess whether students "have the ability to communication effectively" and "to work in interdisciplinary teams?" These are all research questions that we, as engineering educators, can not leave completely to communication specialists. Studies addressing these questions need the experience, insight, and knowledge of engineering faculty to be designed and analyzed in such a way as to be useful to our community.

V. Conclusions

In this paper we have reported partial findings about oral and visual communication from a larger study on communication in engineering education. One major finding is that formal written and informal oral communication receive the most coverage from the set of papers. The paucity of discussion on visual modes reveals the potential for more reflection and research on the meaning and use of visual communication. In addition, the authors tend to claim that participation in formal and informal oral communication improves students' skills without offering evidence to support it. Two of the papers focused completely on informal oral communication, adding important results to the small body of scholarship in this area. However, they also call for more research, especially on the impact of gender composition of the student groups. We would also add to that call the need for research that investigates the impact of race, ethnicity, economic class, and learning style on communication within student groups. We would encourage that research to consider these issues jointly as well as individually since all the 'identities' of a person may influence their communication patterns. Future publications will explore formal and informal written communication, mediation, the interpretation of ABET 2000 Criteria 3(g), and implications of other scholarly work in communication theory.

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References

[1] Koehn, E. (1995). Practitioner and student recommendations for an engineering curriculum. Journal of Engineering Education, 84(3), 241-248.

[2] National Society of Professional Engineers (NSPE). (1992). First professional degree survey report. Publ. No. 3059. Alexandria, VA: Author.

[3] Society of Manufacturing Engineers (SME). (1997). Manufacturing Education Plan: Phase I Report, Industry identifies competency gaps among newly hired engineering graduates. Dearborn, MI: Author.

[4] Accreditation Board for Engineering and Technology (ABET). (2000). Criteria for accrediting engineering programs. Baltimore, MD: Author.

[5] Webster. (1984). Webster's II New Riverside Dictionary. Boston, MA: Houghton Mifflin Company.

[6] Tannen, D. (1994). Gender & Discourse. New York: Oxford University Press.

[7] Natishan, M.E., Schmidt, L.C. and Mead, P. (2000). Student focus group results on student team performance issues. Journal of Engineering Education, 89, (3), pp. 269 – 272.

[8] Haller, C.R, Gallagher, V. J., Weldon, T.L., and Felder, R. M. (2000) Dynamics of peer education in cooperative learning workgroups. Journal of Engineering Education, 89, (3), pp. 285 – 294.

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