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Using Leadership Education Practices to Enhance Freshmen Engineering Student Interviewing Skills

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Abstract

A key component in the leadership education program for graduating seniors in engineering (at a specific university) is interviewing established leaders. Through the interview, small groups of students prepare for and engage the established leader to explore the leader's characteristics, experiences, and methods of leadership. Surveys have found this a more meaningful learning experience for the students than traditional lecturing by the leader/speaker. Further, development of interviewing skills and improved understanding of the value of asking better questions has also been shown to increase student confidence in their ability to communicate, listen, and reflect.

Development of questioning and interview techniques was used to improve communication and engagement in freshmen mechanical engineering students. By having freshmen engage in-class speakers in an interview format compared to traditional lectures, the students actively engaged in questioning demonstrated increased retention of information compared to the group that received the same information via traditional lecture. Through analysis of student surveys, the preliminary conclusion of this work is that by placing the responsibility (and consequences) for learning on the engineering student in limited situations can aid in their development of skills needed to improve their leadership, communication, and engagement skills.

Introduction

This paper presents the results of an experiment to engage freshmen enrolled in an introductory engineering survey class in the development of skills related to asking better questions. Specifically, the experiment was designed to improve student skills related to interviewing an "expert" in the aim that the student engagement would improve learning outcomes. The students were given background information about the expert and a list of expected outcomes for their interview. They were also trained on rudimentary techniques of questioning and interviewing.

Three factors motivated this experiment. First, feedback from co-op employers and hiring interviewers noted deficiency in engagement among a significant number of underclassmen at (specific university) during career-related interviews. Second, the students in the introductory survey class were also struggling with open ended problems in the course's design problem. It was theorized that both problems had a common root – lack of skill in solving "fuzzy" problems. In both cases, the students were faced with situations without clear definition or specific outcomes (such as "Solve for x."). Instead, both situations presented multiple, open-ended challenges to the students that required them to seek information to provide clarity to the problem without an obvious starting point.

The third factor arose after considering the root causes of the inability of the freshmen to succeed at solving open-ended design problems or interviewing for a position. It was speculated that techniques used in the college's engineering leadership course could be used to address both concerns. Specifically, the aspect of teaching the students to ask questions in "open" discussions

to arrive at information needed to obtain an outcome and how to prepare for such questioning (interviewing) when placed in an informational "deficiency" compared to the person with whom you are interacting. These facets were introduced to the survey course to gain preliminary information on effect of student learning about a specific aspect of engineering practice.

This paper presents the background for the techniques used to improve student questioning and interviewing in the context of training students to become more effective leaders and engineers. Further, the actual experiment will be explained, along with the results and instructor reflection on learning outcomes. Finally, planned future efforts will be discussed.

Background

The pivotal aspect of this work was that skills taught to select engineering students to improve their leadership development could be used to help freshmen learn how to ask questions in an open-ended or interview situation to define a problem or obtain information for a desired outcome. The model used for helping students learn these skills was the (unnamed) Leadership Institute's annual leadership class (seminar) that focuses on development of the student's leadership styles through understanding of leadership concepts, emotional intelligence, examining the leadership styles of proven leaders, team building, and self-realization. It is a stand-alone course, not part of a minor or longer development program. [1]

Value of Learning to Ask Questions

While there exists a plethora of literature on the value of teachers using effective questioning to help student learning, there is a dearth of similar literature on helping students develop effective questioning to enhance learning. Much of that literature is actually found in business journals and in the executive coaching field. [2-4] Unfortunately, most of the evidence cited in literature is anecdotal.

Description of the Leadership Training Model

The engineering principle-centered approach to leadership education in the Leadership Seminar was used to focus on the leadership skills that are critical for the engineer to convince (lead) people to invest time and capital in bringing innovation (vision) to fruition. This is done by fostered leadership development with the same effort as the development critical thinking skills – a hallmark of engineering education. Further, this approach enables logical problem solvers (engineers) to understand that decision making is not always, or often, data-driven. Emotions, tolerance for risk, perceptions, and relationships drive human decisions. By analyzing these factors, engineering leaders can formulate strategies to mitigate negative factors inhibiting advancement of innovation, while capitalizing on their ability to take calculated risks, focus on necessary problems, and integrate resources. [1]

The heart of the fall seminar is the interaction between the scholars and the guest speakers for two+ hour "interview" sessions (classes). These speakers are often active CEOs, presidents, or executives of various operations. The willingness of the speakers to educate the next generation of leaders is the single most important element of the class. The speakers selected for the class

are capable of invigorating their audience by sharing their personal experiences, leaving a lasting impression on the students.

However willing and invigorating the speakers may be, the students must be instructed on how to interview the guest speakers. This includes discussing proper interviewing etiquette, as well as understanding the nature of questioning to learn more about the leadership style of each speaker. The two key aspects of the latter include understanding how to narrow the scope of questions from the open-ended nature of leadership to the specific aspect or outcome desired, and the value of subject preparation to put the interviewer (student) on similar footing to the interviewee (leadership mentor/speaker) and maximize the learning potential of the students.

Educational Experiment

The effective questioning experiment was designed to test the effectiveness of student-driven questioning on learning outcomes. A large class of freshmen taking the introductory mechanical engineering course was divided into two groups. Both groups received the same training and preparation for the same speaker. Both groups were asked to attain specific educational outcomes and both were evaluated for learning using the same assessment tool. Further, both groups completed the same self-assessment questionnaire following the exercise. The only difference was one group received the information in lecture format. The other group received no lecture, but instead had to extract the information from the speaker in an interview format.

Preparation for Questioning/Interview

The students were told that they had three outcomes to attain following a presentation (or interview) by a visiting professional engineer. They were:

1. What coursework or classroom training provides added value for the particular practicing engineer in his field? Why?
2. What experience(s) would be valuable for a new engineer in the field of practice for this particular engineer? Why?
3. How would you (the student) go about seeking a job in this particular field of engineering practice?

Each question, at first glance, seems to point to a specific answer or set of answers, and thus seems “closed.” But upon further reflection, the second part of the question made them open-ended. The freshmen would have to understand potential classes and experiences to understand how they would be useful in a future career environment. For freshmen, this was a daunting challenge. They were marginally familiar with the curriculum, but unfamiliar with the content of the classes. And of course, they had little frame of reference for professional application.

As a result, three educational activities were used to prepare the entire class for the guest speaker’s appearance – (1) curricular review and preparation of a complete academic schedule, (2) speaker biography, and (3) lecture on questioning/interviewing skill development.

Curricular Review

Inherently, freshmen are not familiar with their degree requirements or the contents of the potential classes. As part of the introductory mechanical engineering class, all students were required to complete a "career" academic schedule through graduation. This required the student to complete next semester's schedule in a workable form (meaning all classes can be taken with no overlap) and plan what to take each semester thereafter. This was facilitated by a flowchart developed by the department. However, as the majority of students entering the class had not taken calculus (where the schedule starts), most students had to significantly rearrange the chart.

Additionally, the key course sequences (such as statics-dynamics-materials-capstone design) were explored through interactive lecture, showing the students the critical path to graduation. The course sequencing was explained, especially why courses have prerequisites, to help them understand the flow necessary to optimize learning. While this discussion did not explore the depths of course content, it at least made the course purpose better understood.

Speaker Biography

Additional preparation for the activity was delivered in the form of a biography of the speaker, including details of professional achievements and accomplishments as a student. The class was also asked to do research on the company and two projects the speaker was developing. However, it was clear that without a required and graded assessment, few students actually performed this task.

Interviewing Skill Development

To prepare both the student group who would do the "interview only" option and to help the "lecture" group ask more effective questions to meet the required educational outcomes, the students were given training on the purpose and practice of questioning. Without repeating the entire lecture, the students were shown how to address open-ended problems by first identifying or clarifying the issues to be addressed. Then they were given strategies for follow-up to gather the information needed to resolve (or complete) the issues.

The students were told the assessment tool for the outcomes would require them to draw linkages between the professional activities and the courses/experiences/actions discussed in the desired outcomes. Simply listing courses or actions without explaining their value to specific practice of the professional would be insufficient. They would have to understand how the content of the course related to the profession or how the student activity would benefit skill sets needed and how they would be used in the profession.

While this was a general lecture on questioning techniques, it did provide specific examples related to the desired outcomes and to explain why it was necessary to ask deeper questions than just rephrasing the desired outcome questions. For example, instead of asking "How did you experience in <name of class> help you develop as an engineer?," the students were encouraged to ask about aspects of the speaker's work that involved specific topics from the class. This meant that the students had to learn about general concepts to be taught in that class, but also focused the answer on specifics aspects related to the speaker's current job. Then they were

encouraged to use the speaker's answer to develop follow-on questions then focused on other professional engineering experiences the speaker had.

The last training was a discussion of listening and the importance of preparing the questions in advance. The value of listening was explained on two levels – student (or listener) understanding and engagement (or trust) of the speaker. Effective listening was explained as a skill requiring development of a relationship between listener and speaker. No speaker wants to talk to people who are checking their phones or sleeping during the discussion. Once the speaker is "turned-off," there is little chance they will invest the time or effort to explain their positions more completely, especially when there is no other reward structure in place for the speaker. Further, if the listener is otherwise occupied (cell phone, laptop, or even thinking of another question) while the speaker is talking, there is little chance for deep intellectual connection or understanding. When students fully engage, literature shows that they become aware of the context and the impact of the context. [4]

Results

The class was divided roughly in half with half interviewing the speaker only (no prepared lecture) and the other receiving a prepared lecture from the speaker. While both groups could ask questions, one group could only ask questions to achieve the desired educational outcomes. The speaker volunteered no information. Finally, it should be noted that the lecture given by the speaker provided information relevant to the desired outcomes as part of a broader talk about their profession. They were not framed by the speaker as "The answer to desired outcome #1 is …," but were discussed in the context of his overall view of his profession.

Assessment of Achieving Desired Outcomes

Several weeks after the speaker's visit, and following an examination over different materials, students were assessed on their mastery of the three desired outcomes. The assessment tool was the same between the groups and consisted of a rote recitation section (30%) and a full explanation section in essay form (70%).

The results were not significantly different for the two samples in both the recitation and the essay sections, as seen in Tables 1 and 2. For the recitation section (shown in Table 1), the difference between the Group 1 (interviewing, sample size of 43) and Group 2 (receiving lecture, sample size of 48), given the standard deviation (s) of each sample the calculated P value for difference of the means was 0.51. For Table 2, the calculated P was 0.16 for the difference in the means between the essay grade (assessment) of the two groups.

Table 1. Results of recitation section assessment between groups

Mean of Group 1	0.78	Mean of Group 2	0.80
s_1	0.14	s_2	0.15
n_1	43	n_2	48
		P (two tail)	0.513

Table 2. Results of essay section assessment between groups

Mean Group 1	0.77	Mean Group 2	0.72
s_1	0.16	s_2	0.18
n_1	43	n_2	48
		P (two tail)	0.164

While these results were disappointing, they were not entirely unexpected. Because of the large number of students in each group, it was clear before the test that not all students would participate in the questioning of the speaker. Therefore, the students who asked questions were recorded and their performance on the assessment tool was separately analyzed as shown in Table 3. In that case, there was a statistically significant difference between Group 1a (students who did ask questions, sample size of 13) and Group 2 to a P of 0.026.

Table 3. Results of essay section assessment between groups (1a) and (2)

Mean Group 1a	0.85	Mean Group 2	0.72
s_{1a}	0.10	s_2	0.18
n_{1a}	13	n_2	48
		P (two tail)	0.026

Student Evaluation of the Experience

The students were asked to assess their impressions of the exercise including (1) value of learning questioning, (2) would they rather receive the information by interview or lecture and (3) what would they change from their experience.

From Group 1 (interviewing group), 31 responses were obtained. On a scale of 1-5, they found a value in learning questioning techniques (4.15 mean response), but were more comfortable with receiving the information in lecture format than via interviewing (68% preferring lecture). The results were similar from Group 2 (28 responses) even though they did not do the interview, with a 4.01 mean response finding value to the questioning skills development and 65% preferring lecture. Both groups offered little input as to how to change the exercise, but several students in Group 1 indicated they were glad to have had the experience because they felt they were notably weak in this area of personal development (interviewing).

Conclusions

This work is preliminary and no significant conclusions can be drawn. However, three interesting trends were observed. First, freshmen engineering students were exposed to skill development that they found useful, albeit uncomfortable for some. Second, interview format for large number of students is not an optimally designed exercise and should be limited (the fewer the students, the better) as seen by the differences between the student performance for those that

actually asked questions of the speaker. Finally, it should be noted that student engagement (asking questions) did seem to have an effect on success with respect to the learning outcomes. However, it should be noted that the students that did ask questions did finish with a higher average grade for the course than the overall student population, but not to a statistically significant level ($P<.05$). Further, the total cumulative GPAs for all courses among the two groups differed by only 0.05 on a 4.00 scale and were not statistically different.

Perhaps, the greater value in this work will be in designing future efforts to help engineering students develop approaches to solving open-ended problems and addressing open-ended situations. A review of literature on senior design and design approaches is already underway to expand upon the question/interviewing skill development effort. Further, additional opportunities for all students to engage in interviews are planned for the next offering of the course.

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