Providing Connections Between Freshmen and Senior Engineers Through a Design Experience

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Introduction

The typical engineering curriculum in most programs revolves around math, physics, and chemistry components. Students prepare for future engineering activities by building a foundation that will allow them to function at the upper levels of their majors. Little or no connection to those upper level courses is provided. Within an educational mode that may seem to be the correct way to prepare students; but when carefully analyzed, that singular focus of the curriculum may be incomplete. Most will agree that it is necessary to pique the interest of students in their future careers with material that is significantly important within that career. It is not enough to simply require courses that do not present specific connections to the future majors and hope that these same students will continue in the engineering programs. It is with that thought in mind that a new component of the Residential Option for Science and Engineering Students (ROSES) course was initiated in Michigan State University's College of Engineering. The plan was to provide freshmen students with:

- An immediate sense of why they were taking lower level required courses
- A means by which they could interact with students almost completed with their bachelor of science in mechanical engineering degrees
- A means by which they would have access to the years of learning that the senior students possessed
- A sense of actual future courses in their major

The mechanical engineering section of the ROSES class was given such an opportunity. Students as individuals or in two-person groups were teamed with Senior Capstone Design students to both shadow and participate in the design activities of the senior capstone design team. ROSES students were asked to meet with the senior students and carefully evaluate the activity. Students were allowed to practice their teaming skills through the planning and implementation aspects of the assignment and their communication skills through the reporting phase. This paper provides the relevant assignments and student feedback on the experience.

The Program

In the week before classes began in fall 2003, careful planning went into the pairing of incoming freshmen mechanical engineering students with senior capstone design teams in the Department of Mechanical Engineering. The projects in the capstone design course ranged from automotive

industry foci to investigations of the required number of crisplets on the top of a breakfast cereal and how to maintain those numbers. The senior students are given time to make a case for their participation in the specific design team. The teams are then matched to the projects that will most closely utilize their skills. The freshmen were also given a chance to select the project that was most interesting to them. They did not need to have any real expertise in the specific project area. It involved more of a topical interest that would then allow them to get past the issue of required activities. The critical note is that the freshmen students are not officially in the mechanical engineering major until their junior year. This junior admission leaves many students adrift in relation to being a true part of their major. It was hoped that any activities that unite freshmen and upper level students would be beneficial to the educational process.

As the idea for the assignment unfolded, the focus was always on allowing incoming students the opportunity to interact with their senior engineering colleagues without the pressure of massive amounts of time commitment and required assignments. The sole purpose was to provide younger students with a comfortable setting into which an enormous amount of learning could take place, learning that might not actually occur in the classroom. Younger students could talk to seniors, and the peer type encounters could lead to a wealth of information being imparted. The thought was also to allow more of a comfortable atmosphere than a structured semester lab that required students to simply mimic upper level activities. Students were informed that they should make every effort to use the opportunity to create friendships that would allow them to gain both worthwhile and truthful information about their major.

During the first class of the semester, the freshmen were provided with the 19 projects that would be investigated by the seniors. With scheduling concerns being most important, they choose the groups in which they would interact. The available time-slot groups were then chosen for their interest level for the student. Detailed information (Appendix A) was given to the freshmen on how to contact the senior design groups, what their purpose was in interacting with the seniors, and the importance of utilizing older students for their expertise in the educational system. A pre-survey was also administered (Appendix B) to discover the current attitudes of the freshmen toward such a project, teamwork, and communication. Of the 17 student respondents, the majority of answers fell in the Strongly Agree to Agree categories. The students felt that the experience would be valuable and useful in their education.

The senior engineering students were also provided with the same information as the freshmen so that both groups understood their responsibilities. The seniors took a positive position in the process, seeing it as a good method to impart their own wisdom to new engineers in the system. There was also a feeling that even though the freshmen did not have any extensive background in the mechanical engineering area, they did possess interest and common sense, both of which the seniors could utilize in their design investigations.

Since very few of the ROSES students had practiced the engineering design process before, a design faculty member made a presentation on design to the ROSES class during one of its weekly meetings. This presentation emphasized design as a creative problem solving process and introduced students to the various stages of the design process. During the presentation numerous examples were provided in an active learning style to address problem recognition,

problem conception, and synthesis. The presentation did concentrate on these specific design stages, since it was expected (due to the volunteer nature of the ROSES students' participation) that these were the stages in which the ROSES students would be involved.

For the rest of the semester, the freshmen were then allowed to interact with the senior engineers as much as they desired. For some this involved the first and only meeting that they had with the senior group. For others, it meant meeting on a weekly basis and truly experiencing what was unfolding in the design group. Some of the freshmen were even invited to participate in the culmination of the semester's work, The Student Design Conference. The beauty of the structure was that no one was forced to participate above a comfortable level. Students choose to involve themselves at a level that fit their particular needs. For some who were surveyed, the issue of talking about their own ideas with older students was uncomfortable, so they were not forced into a semester of trauma. A single meeting was enough to allow the beginnings of conversation. Others enjoyed the interaction and let it flow for the entire semester. A detailed report from the freshmen at the end of the activity was intended to be a document that allowed students to talk about what they had learned, how they were treated, and the reasons that they felt interaction with senior students would help in their career path journeys. Perhaps some would call the reports reflection papers. They reflected upon the experience and their reactions to it.

There is no grade given for the activity other than as a simple participation grade for the assignment. Since there was little or no chance that the students would not want to participate, we did not feel that a grade was necessary. More so, we wanted the students to participate out of a desire to engage themselves with the older students

At the end of the semester, a post-survey was given to see how the project had succeeded and also to provide information on areas that needed improvement (Appendix C). The pre and post surveys were fairly close in the answers provided by the freshmen, but one interesting element emerged. The freshmen in the beginning felt that they had little uncomfortableness in sharing their ideas with older students. As the semester ended, they expressed a change that said that they were actually were uncomfortable with this activity. It showed us that there was a need to investigate this feeling and work on making it easier for the freshmen.

The senior engineering students as a whole responded with positive comments about the experience. They felt that creating a bond with incoming freshmen allowed them to explain some of the pitfalls that could be avoided with pre-knowledge. They also felt that providing the freshmen with insights into what their early courses meant to their future work would be beneficial. The process mirrored the older brother/sister giving of their experiences to aid the growth of the younger brother/sister.

Conclusions and Lessons Learned

A relatively easy procedure of teaming freshmen with seniors in an existing Mechanical Engineering Senior Capstone Design Course provided a great deal of learning for all parties involved. Freshmen were allowed to participate in design activities that well could shape how they perceive their existing courses. Seniors were given the chance to mentor younger students

and provide information and counsel that they might never be able to duplicate in any other courses.

Timing is very important to the success of this program. During the piloting of this program it became clear that starting the program even earlier in the semester would be beneficial. For its next implementation the ROSES students will be assigned to the capstone design teams much earlier. In this way the ROSES students will have a better opportunity to be involved in the problem recognition stage of the design process, one of the more ignored stages in our mechanical engineering curriculum.

More attention needs to be given to training the seniors in mentoring. This is a key aspect of working on a design team (can you say summer interns?) and fits logically into the learning objectives for the capstone course. Since every capstone design team is assigned a faculty member as an academic advisor, the program could be greatly enhanced through greater involvement of the academic advisor with the ROSES student. This will give the freshmen some additional networking opportunities.

The volunteer nature of this activity worked primarily because of the select aspect of the ROSES students. Academically, these are among the top high school students admitted to Michigan State University and their motivation is extremely high as demonstrated by the early selection of mechanical engineering as their major. To implement such a program for a broader spectrum of engineering freshmen might need a more structured format with required assignments for the freshmen, in order to be successful.

The conclusions we drew from the surveys were that the freshmen basically retained their beliefs that the activity would be valuable in their academic lives. They learned from their interactions and this was reinforced with the survey results. One area that would need work would be in the concern of simply talking to the senior students. There was an increase in the number of students who felt that they were uncomfortable in talking opening with the seniors. This is an area to be addressed with next year's class.

The outcomes for the activity show the need for greater interaction between freshmen and seniors. This interaction will help to disseminate information about materials to study, areas to concentrate on early in a young engineers life. The freshmen expressed willingness and an interest in gaining from senior engineering students. The seniors also expressed a concern that they do not do enough to pass on information to the younger students. We have learned that it is important for younger engineers to have a continuous flow of information from students who have gone before them.

Appendix A

ROSES and ME 481

Purpose:
To allow freshmen students the chance to interact with senior engineering students within the context of a design, build, test project with industrial ramifications.

- Students will spend at least one session together discussing the problem involved in the industrial project.
- ROSES students should be considered partners in the process and play a role as listeners to and evaluators of the problem itself and possible solutions chosen by the ME 481 team.

The interaction of the freshmen and seniors should provide an impetus for critical thinking on the whole picture that revolves around engineering and the need to analyze carefully problems as they arise in the world and also the many solutions to those problems.

ROSES students will:

- Make contact with the ME 481 Design Team of their choice. They will email you to make contact during your normal team/advisor meeting
- Work with the team for 1 discussion period and if possible travel to the industrial sponsor for a plant visit
- Write a detailed report on their interaction with the ME 481 team members and their impressions of design at the senior level

ME 481 team members are asked to:

- Provide a mentoring atmosphere for ROSES students
- Include the ROSES student in discussions
- Provide an environment that allows ROSES students to contribute

Appendix B

Pre-survey Fall 2003

Working with Senior Engineering Students on their ME 481 Senior Capstone Design Project

1. It would be valuable to work with senior mechanical engineering students on a design project.

SA	A		D	SD
1	2	3	4	5

2. There is value in freshmen students getting involved in design projects early in their academic careers.

SA	A		D	SD
1	2	3	4	5

3. I am comfortable talking about my ideas with "older" students.

SA	A		D	SD
1	2	3	4	5

4. I see value in teamwork when it comes to engineering.

SA	A		D	SD
1	2	3	4	5

5. Working with senior engineering students will help to improve my communication skills.

SA	A		D	SD
1	2	3	4	5

Strongly Agree Agree Disagree Strongly Disagree

Pre-survey	SA	A		D	SD
1	9	7	1		
2	8	8	1		
3	3	6	6	2	
4	11	6			
5	5	9	3		

Appendix C

Post Survey Fall 2003

Working with Senior Engineering Students on Their ME 481 Senior Capstone Design Project

1. I found it valuable to see senior mechanical engineering students work on a design project.

SA A D SD
1 2 3 4 5

2. There is value in freshmen students getting involved in design projects early in their academic careers.

SA A D SD
1 2 3 4 5

3. I feel more comfortable talking about my ideas with "older" students.

SA A D SD
1 2 3 4 5

4. I see value in teamwork when it comes to engineering.

SA A D SD
1 2 3 4 5

5. Working with senior engineering students will help to improve my communication skills.

SA A D SD
1 2 3 4 5

Strongly Agree Agree Disagree Strongly Disagree

Post-survey	SA	A		D	SD
1	7	7	3		
2	6	11			
3	1	4	10	2	
4	11	6			
5	3	11	3		

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