Industry Capstone Projects as a Vehicle for Faculty Development

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Abstract: There is a trend in Engineering education pedagogy focus from problem-based learning to project-based learning. An impediment to this shift in Engineering Education lies in faculty preparation. Strategies to help faculty develop skills while they are working is essential to providing project-based learning activities within engineering programs. Interviews conducted suggest that senior projects are a valuable steppingstone for faculty that initially have no real-world experience in engineering or manufacturing. Allowing faculty to participate in these projects allow them to create industrial contacts and see the skill sets their graduates will be using. The projects provide faculty credibility to the students because they are working with them to solve a common problem. Finally, the paper provides best practices in the senior project program as well as the roles and responsibilities of the faculty, students, and industrial partners that participate in it.

1. INTRODUCTION

Trends in Engineering education pedagogy focus on increasing the application of skills in a move away from problem-based learning to project-based learning. Reasons for this shift center around engaging students in higher order learning activities to address retention, persistence, and completion of Engineering and Technology programs. (Chandrasekaran, 2012). A barrier to this fundamental shift in Engineering Education lies in the faculty preparation. Because engineering education has little focus on skills development (Dewey, John. 1963) Many Engineering educators are woefully underprepared to implement project-based learning in their curriculum (Aglan, H.A. 1996). This, coupled with declining numbers of vocational education faculty, creates an environment where the necessary skills and knowledge needed to maintain a project-based learning curriculum do not exist within most Engineering or Technology programs (Besterfield-Sacre 2014, Hartman, B.A 2000). There are strategies to help faculty develop skills while they are working. This paper examines the impact of mentoring senior industrial capstone projects on engineering technology faculty. The research uses a qualitative case study approach where faculty are interviewed to determine their existing comfort and skills managing projects.

The Tarleton State University Engineering Technology program has been conducting an industrial-based senior project program for over 20 years, utilizing program faculty as project mentors. While the impacts the projects have on students are well-documented, impact on faculty is less understood. A continual and planned interaction between industrial partners and students might have an impact on faculty members, particularly those with limited industrial experience. Providing this experience could have a multidimensional impact on faculty through working with students on a project-based assignment, interacting with industry and experiencing how they go about solving problems, modeling professional behavior with other people on the team, and seeing how content that they teach is applied in the real world. Having these experiences might have impact on their teaching and how they teach their classes.

To investigate this, the study used a qualitative case study methodology (Creswell 2014). The population of the study was the faculty of the engineering technology department. A qualitative semi-structured interview guide was developed (Turner 2010) with questions focused on using a faculty's teaching history,

industrial history, managing industrial projects, and the comfort level of faculty managing students in projects. The framework for questions consisted of eight questions grouped into the previous four categories:

1. Teaching
   a. Describe your teaching experience.
   b. What key takeaways do you have from the mentoring experience? Have you used anything gained in subsequent teaching?
2. Industrial Experience
   a. Please describe any work experience you have in industry; how long, type of industry, full-time, etc.
   b. Describe some of the projects you were involved in. Which were most rewarding and which may have been least rewarding?
3. Managing Industrial Projects
   a. Describe any experience you have in managing projects of any kind?
   b. Do you think mentoring these projects has helped you individually or professionally? How so?
4. Managing Students in Projects
   a. Describe your comfort level in working with students and industry participants on projects
   b. What might you do differently when mentoring your next group of students?

There were 10 faculty who qualified for directed interviews. Comfort level managing student industrial projects was reported based on the responses on each of the interview categories. Table 1 provides summary information about the respondents. Pseudonyms were used in place of actual names of participating faculty members (Creswell, 2014).

Table 1. Participant Coding Sheet

Table 1 Participant coding sheet Topics:	Dr. Smith	Dr. Rice	Mr. Prince	Dr. Mora	Mr. Sanchez	Ms. Wheeler	Mr. Griffith	Dr. Moses	Dr. Barry	Mr. Cameron
Teaching experience (years)	7	5	6	21	20	5	2 +	2	1	11
Industry experience (years)	10	40	30	1	2	10	12	3	0	2
Project experience (number of)	10+	30+	10+	30+	2	5+	0	2	1	6
Comfort level with students and industry	Industry High - Students, not quite so high	Industry High - Students, not quite so high	High	Industry High - Students, not quite so high	High industry low	High	High	Industry High - Students, not quite so high	High	High with students medium with industry
No. of sr. projects involved in	15	4	15	20	7	3	5	2	1	7

2. DISCUSSION OF THE FINDINGS

2.1. Teaching experience

The more teaching experience the subjects had, the more they valued project-based learning. Faculty members Smith, Rice, Prince, Sanchez, and Wheeler all highly valued the project-based learning activities in their own classes and in mentoring the senior project classes. This tracks with the interview language that indicated the more comfortable the faculty was teaching the groups in applied projects, the more likely they would be in using that type of instruction in classes. Faculty such as Drs. Ortiz, Moses, and Barry, while supportive of the senior project classes, indicated that they would be less likely to use project-based education in the classes they teach. However, faculty that are not using project-based education within their classes indicated that they were using the experiences they gained in the senior project mentoring experience to provide examples of application to undergraduate students that are in their classes.

2.2. Previous industrial experience

Not surprisingly, faculty that had more industrial experience were more comfortable mentoring the senior projects and were more likely to use project-based learning in their classroom. These faculty (Drs. Smith, Rice, Mora, and Mr. Prince) had over 10 years of industrial experience and indicated that they were very confident in mentoring the student projects. While the older and more experienced faculty indicated that they were comfortable teaching the senior projects, faculty with less industrial experiences expressed several different activities. Dr. Barry indicated he used the project class to model behavior of how engineers should interact with a client. Dr Barry talked about listening skills and explaining engineering phenomena to the customer because the customers may not be trained in the discipline that they are asking them to perform. When asked if he planned to focus on this, Dr. Barry indicated that initially he did not. However, the types of projects he was managing required a lot of calculations and explanations to the customers.

Some common experiences were found in talking about the least favorite industrial project experience, which focused on situations where the company changes the scope of the project unexpectedly. For faculty with an industrial history, this was less stressful, but faculty with less industrial experience viewed the change with a great deal of stress. When we examined why this was stressful, the faculty members with less industrial experience tended to treat the senior project students as an independent group who they were providing advice to. Faculty with more industrial experience treated the group like employees they were responsible for and this resulted in more deliberative approaches when the scope of the project changed. That is, inexperienced mentors perhaps fretted over changes and hoped for the best from students while experienced mentors provided more direct guidance. Dr. Rice indicated, “You have to plan that the customer is going to change their minds. That’s just how customers are.”

2.3. Managing industrial projects

Once again, the prime indicator here was industrial experience. Faculty with the most work experience indicated they felt their role was to act as a resource and tell their group when they were not going to be successful. Faculty with less industrial experience tended to be more active within the team providing specific tactics to solve problems. Faculty with more industrial experience tended to ask questions and challenged assumptions to provide feedback to students or help the team work through problems.

There was a distinction in faculty with less industrial experience in that they were more likely to change what they were teaching in their classes. When faculty with more industrial experience were asked if they were ever challenged to change what they were teaching based on what they observed in a senior project, the answer was yes, but they felt they were already aligned.

2.4. Managing students’ industrial projects

Previous sections have already indicated that faculty with more industrial experience were more

comfortable mentoring senior projects. In this question, there seems to be a consensus among all the faculty that having a more detailed plan for projects up front is desirable. Faculty with more industrial experience tended to be less tolerant about slippage in time for the projects and were unwilling to move forward until there was a solid plan in place. There was a difference between faculty in redirecting students' behavior. Dr. Ortiz indicated that she tells her students what they should do in their proposal, but if they don't do it, she will reflect that in their final grade.

3. CONCLUSIONS

Experience is the key, not only in mentoring senior projects, but also in doing project-based learning in a college classroom. However, for faculty without industrial experience, they seem to value the experience of working with outside companies. The interviews would suggest that senior projects are a valuable steppingstone for faculty that initially have no real-world experience in engineering or manufacturing. Allowing faculty to participate in these projects allow them to create industrial contacts to see what skill sets their graduates will be using. The projects provide faculty credibility to the students because they are working with them to solve a common problem. Finally, inexperienced faculty become more at ease working in a team-based project using application-based, project-based learning.

4. FUTURE RESEARCH

Future research on this topic could include the impact of project-based learning on student retention and persistence. Additionally, there is argument that because project based learning focuses on higher levels of learning on the application levels and above that this student center focus will provide a deeper level of learning and thus a more prepared student. Without assessment evidence of this it will remain speculation. Finally, because we know that project-based learning is time and resource intensive it would be useful to look at barriers of implementing and sustaining project based education in universities.

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