Community-focused Senior Design Practicum Projects

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Abstract

Senior design practicum project is an important aspect for gaining undergraduate engineering accreditation. Most undergraduate engineering senior design projects are disciplinary focused with a relatively straight forward problem definition by the stakeholder. Some senior design projects may have a flavor of interdisciplinary thinking but for the most part they do not allow the students to address the problem from a larger socio-technical system perspective. We experimented with a new approach to design interdisciplinary continuity in senior design practicum projects that also address a strong community need. The unique partnership involves Engineering Management senior design students, Industrial-Organizational psychology masters students, and a regional rural healthcare system. Unlike traditional engineering discipline focused senior design projects, the project sponsored by the regional rural healthcare system has a broader socio-technical problem context. The project focused on developing internal and external programs to educate the local community on the opioid crisis facing rural America. Interdisciplinary communication methods used by student teams to engage various community stakeholders and the project sponsors are discussed. The challenges and lessons learned associated with connecting a large community project across three semesters in two different departments with different learning objectives are discussed.

Introduction

A senior design project course is designed to satisfy Accreditation Board for Engineering and Technology (ABET) engineering design criteria. ABET Criterion 5 on Curriculum describes the integration of content as follows: *" The Integration of Content: Baccalaureate degree curricula must provide a capstone or integrating experience that develops student competencies in applying both technical and non-technical skills in solving problems.*[1]*"* Several papers address the various approaches, challenges, and lessons learned in senior design capstone projects [2]-[8]. Most senior design projects in the engineering disciplines focus on a relatively straightforward disciplinary problem. The tasks of defining the problem definition and the project scope are relatively easy. Some senior design projects are interdisciplinary in nature in that they cut across two or more disciplines. We could potentially categorize the senior design projects into the following three categories:

1. Single disciplinary senior design projects: Projects are tightly focused to address various aspects of a single discipline problem. In most cases, the students are not expected to spend a whole lot of time in problem definition since it is mostly provided to them by the project sponsors or the course instructor.
2. Single disciplinary with multidisciplinary exposure senior design projects: These senior design projects introduce interdisciplinary thinking but for the most part they still focus on a single discipline. The multidisciplinary content is more like a gift wrap that covers

the core senior design that is still mostly a singular disciplinary problem. These projects provide a contextual basis for the students to understand the importance of solving a disciplinary problem, or the economic/social benefits of their proposed solution to the community.

3. Interdisciplinary senior design projects that provide immersive interdisciplinary experience: These senior design projects are truly interdisciplinary. They may require teams to be formed by students from various disciplines. The interdisciplinary experience is in-depth and immersive. For example, students may be addressing a larger socio-technical system problem where the problem identification and definition may be a problem in itself. These projects typically address the broader impacts across disciplines.

Our approach: Community-focused projects

We experimented with a different approach to design interdisciplinary continuity in senior design practicum projects to address a strong community need. The unique partnership involved Engineering Management senior design students, Industrial-Organizational psychology masters students, and a regional rural healthcare system. Unlike traditional engineering discipline focused senior design projects, the project sponsored by the regional hospital involved a broader socio-technical problem context. The project focused on developing internal and external programs to educate the local community on the opioid crisis facing rural America. As such, one could argue that this project was still mainly focused on a single discipline with a multidisciplinary context (i.e., opioid education as identified by the healthcare system).

The regional healthcare system had not previously played a prominent role in the community to address the local opioid epidemic beyond immediate care. However, recently, the organization added opioid education and prevention to their strategic plan. There exist diverse opinions, internally and externally, on the most effective role of a hospital in addressing community stigma. The project focused on querying internal hospital staff and community perceptions on the envisioned role of the healthcare system in addressing this local crisis. The projects goals are listed below:

- Assess staff and community attitudes on contributing factors and envisioned role of the hospital relative to local opioid crisis;

- Develop educational intervention to shift selected staff and community perceptions.

The project synopsis was provided by the project sponsors, the healthcare system's Director of Medical Research and the Administrative Director of Organizational Development (refer to Table 1.) The project outputs of first semester were provided as project inputs for the second semester students. Later, the project outputs of second semester were provided as project inputs for the third semester students.

Table 1. Project synopsis (Provided by project sponsors)

Lessons learned/Challenges faced by the instructors

Even though we (the course instructors) along with the project sponsors spent a substantial amount of time planning the project before the course began in each of the three semesters, we discovered quite a few issues as the project progressed. Some of the important lessons learned by the instructors are listed below:

1. Project definitions for the three semesters:

Defining the project for the students that cuts across three semesters involving student teams from different disciplines/course objectives was a major challenge. For example, the second semester project initially seemed more geared towards targeting community change rather than

organizational change. While there were some overlaps between the first and second semester projects, students in the second semester had to be focused on organizational change including how to prepare employees for change, manage employee resistance/readiness for change, provide recommendations to leadership about how to navigate the change process, etc. Many students felt that the third semester project was not well-defined, and their capstone experience could have been better.

2. Expectations from the sponsors:
   - A document entitled "What to expect from the project sponsors?" was provided to all students in the course on the first day of class. The project sponsors introduced the project to the students. They were available throughout the semester to address any questions that the teams may have. The sponsors also "dropped by" occasionally to check project progress. It is critical that students are respectful of the sponsor's time (the sponsors cannot help much with last minute requests or provide students with ready-made solutions to their questions/problems.) The project sponsors attended the mid-term and final presentations and also reviewed the student team final project report. The project sponsors played an integral role in evaluating student projects and provided the course facilitator with critical information for grading purposes. Student teams are expected to communicate clearly with the sponsor. If they still had any questions about the project, then they were instructed to reach out to the instructor. Based on conversations and feedback from the sponsors and the students, we believe the following points are important reminders and lessons learned for student teams: When working on a community issue, the projects are "live projects", and the project sponsors themselves may not necessarily have all the answers to students' questions.
   - The reality is that sometimes things happen in an organization (especially during Covid-19 and working with a healthcare system) that are beyond the control of the sponsor. Sometimes, projects get scrapped at the last minute or their original scope gets changed.
   - The project sponsors are expecting student teams to research and come up with potential solutions. It is always a good idea to check with the project sponsor to see if they have any information that can be shared with the team.
   - The project sponsors may not give you their thoughts/suggestions on the solutions since they want to **foster the students' independent and critical thinking.** They know what they know and want to explore the boundaries of what they know through the student teams.

3. Individual course grade and timeline constraints:

There are several inherent challenges in a senior design capstone project course including, :

   - The course is based on a team-based work model. If some students in a team are simply interested in earning a passing grade, it negatively impacts the other dedicated members of the team.

- The students have timeline constraints – they need to get the project done within a semester. Any project mission creep or project redefinition (even for valid organizational reasons) is viewed negatively by many students. The students are taking other courses as well and any major changes in the project scope makes it difficult to manage their time.

4. Project team dynamics:

The student team size is a function of the total number of projects that are sponsored and class enrollment in a given semester. Student teams of 5-7 students per team were formed for the Engineering Management Senior Design courses. In a few student teams, there were student commitment and accountability problems. For the most part, team peer pressure motivated all team members to contribute and put in their fair share of work on the project. In hindsight, it would seem that the student teams should have been smaller. We think that we should have capped the team size to about 3-4 students per teams for enhanced team member accountability, meeting logistics, and team cohesion. Notably, student teams in the Industrial-Organizational psychology class were smaller (about 4 students per group), which helped inform that this team size might be preferable and more manageable.

5. Intra-team evaluation:

Qualtrics-based intra-team evaluation survey instrument was used by the instructor to gain insights on an individual student's project participation and work ethic. Each member of the team provided an evaluation of their team members working on the project. The evaluation results were shared with each student as an aggregate (without disclosing the names of team members who provided the comments) if there were project participation issues. The intra-team evaluation was used by the instructor to adjust the team assignment scores based on their peer-perceived participation levels. We feel that intra-team evaluation is a good way to capture student participation levels both inside and outside of the classroom.

6. Students' Educational Background and Experience

Most of the students (in all three semesters) did not have a foundational health background such as why community members may struggle with opioids, why there might be public resistance to educational efforts, and so on. The semester timeframe was not fully adequate to provide students enough time to first learn about the community issues to inform their change management recommendations as well as essentially learning and developing skills around the change management recommendations themselves. Additionally, community members as subjects of change may not necessarily be quite the same as employees as subjects of change.

7. How to Meet with Student Teams

About half the students in the Engineering Management senior design course were assigned to one of three teams working with the regional healthcare system. During the initial weeks of the semester, the instructor and sponsor assembled all three teams in a room and addressed them collectively about overall project goals, course expectations, project deliverables, etc. This made sense since the three teams were working on a common problem though independently. During the initial classes, as the project details were introduced and shared with students, there was notable overlap of student questions. However, as the project progressed, the instructor and/or sponsor started meeting with each team separately to discuss their team specific project approach. This was beneficial to both the students, and the instructor/sponsor in terms of getting to know each other better and having a customized team-specific dialog.

8. Providing student feedback

Both the instructor and the sponsor provided students with their feedback. Special attention was paid to ensure that the instructor and the sponsor agreed on evaluation rubrics and project expectations. We did not want vastly conflicting advice from the sponsor and the instructor to the students. For the most part, the sponsor provided advice on the technical aspects of the project and the instructor provided support on the non-technical aspects of the project. The role of the instructor was also to normalize the evaluation scores received by various project sponsors of student projects. Providing pointed and timely feedback is helpful for students. The students do not like generic or delayed feedback. The instructors/sponsors should stick with providing excellent project guidance. However, the instructors/sponsors should be careful not to hinder the students' critical problem-solving abilities by providing them with solutions or over direction on what to do.

9. Teaching during Covid-19 pandemic

The first semester of the Engineering Management senior design course was conducted mostly over Zoom. The third semester of the Engineering Management senior design course was conducted in dual modes: the first part of the course was conducted over Zoom while the second part of the course was in person with masks on. It was a challenge for the instructor/sponsors to fully connect with students. On-site visits with the healthcare organization were not possible. Despite the various distance technologies that are available, we feel it is difficult to reproduce the in-person student experience. Without interpersonal interaction, many of the soft skills are often not fully experienced by the students learning to conduct team-based senior design project via distance settings.

Conclusions

The community-focused design project was different than a typical engineering senior design project that focuses mostly on technical skills. The community-focused design project discussed in this paper focused on the technical skills as well as many soft skills such as communication both within the team and the project sponsors, project management and control, interpersonal

skills, and patience. The lessons learned by the instructors and the project sponsors were helpful and are being used to refine the future offerings of the capstone course. It is hoped that the lessons learned may also be helpful to the senior design instructors' community at large.

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