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Addressing Gaps in Teamwork Education Through Cross-Department Collaboration in Capstone

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Teaming and collaboration within the academic setting have inherent challenges in preparing students for post-academic teaming and collaboration. Students are typically all from the same discipline and in the same role, which is uncommon and non-ideal for teams. Through an ongoing collaboration between the biomedical engineering and marketing departments, we have provided unique opportunities for students to learn about teamwork and collaboration. Marketing student teams provide a Capstone-like marketing report for select ongoing engineering Capstone projects, with direct collaboration between the two student teams. The inclusion of an ongoing cross-department collaboration in the capstone experience has been an enlightening and worthwhile experience for the department and the students. We have learned a great deal and will continue to refine and improve collaboration, sharing these lessons to inform similar initiatives.

Keywords: Design, Team, Capstone, Collaborative Learning

Introduction

Texas A&M's biomedical engineering department's curriculum includes a six-course sequence that culminates in a final two-semester capstone experience. Within this sequence, we employ the pedagogical framework of collaborative learning in various ways, including assignments that simultaneously bridge two courses. Here, we will discuss a unique form of these assignments: the biomedical engineering department's collaboration with the marketing department on capstone-like projects. Specifically, the marketing collaboration is a special instance of the "vertical integration" assignments throughout the biomedical design curriculum, which also include biomedical senior teams working with biomedical juniors or sophomores on engineering projects. Overall, the "vertical integration" assignments have had positive impacts on student learning opportunities, with positive student feedback, and continue to be improved as concerns are identified or arise. Other previously published studies that explore cross-collaboration with marketing/business departments and capstone projects provide insights but vary in size and focus, typically addressing a single collaborative project [1], focusing on other extracurricular activities such as competitions [2], or emphasizing cross-disciplinary instruction [3]. This initiative has included 19 collaborative projects over the past three years, engaging over 150 students, with a focus on providing more authentic student peer interactions and imitating cross-disciplinary project teams and roles. It demonstrates another method of cross-departmental collaboration to enhance student learning and prepare students for real-world teamwork challenges.

Challenge Statement

ABET, which provides accreditation of academic programs, includes in its criteria for engineering programs "an ability to function effectively on a team whose members together provide leadership, create a collaborative environment, establish goals, plan tasks, and meet objectives [4]." Teaming and collaboration within the academic setting have inherent challenges in preparing students for post-academic teaming and collaboration. The most significant challenge is that student teams are often composed of students in the same discipline and class. This homogeneity within teams stems from several logistical and practical constraints, such as the additional administrative burden of organizing beyond the traditional academic structure of colleges and departments. Also, it is worth noting that the learning objectives differ across two separate college disciplines. However, as a result, students rarely work on teams that have differing roles or with other disciplines. This homogeneity leaves students unprepared for some aspects of teaming and collaboration. With proper preparation and effort to expand teaming and collaboration activities, the capstone learning experience can be extended and enhanced. Interdepartmental collaboration with engineering is the immediate path to address homogeneity gaps, but going further by enabling collaboration with other, more distinct departments can further enhance the experience.

Novel Initiative

The marketing instructional team initially reached out to the biomedical engineering department, looking to pilot capstone experiences in their senior-level courses. They ideally wanted real projects, either learning from best practices or directly collaborating on them. Typically, interactions with other departments on a Capstone project involve students from other disciplines contributing directly to the project or, more rarely, serving as a full multi-department Capstone team. What makes this effort unique is that capstone teams act more as sponsors and subject-matter experts, allowing marketing teams to create a marketing report for their project rather than being directly accountable for the work produced [5]. In short, engineering students present the problem and their solution at a high level, and then the marketing students do all the work of creating a marketing report for their capstone-like class.

The marketing students get a real project and student subject matter experts. The engineering students experience a different collaborative role (one where they must share information but don't actually perform the project work) and practice sharing information while under a non-disclosure agreement (NDA). This approach benefits all parties by providing real-world experience, fostering interdisciplinary skills, and producing valuable reports for sponsors, encouraging similar initiatives.

The first project cohort was three years ago, and we completed one cohort every spring. Before the start of the second semester of Capstone in the spring each year, the biomedical engineering and marketing instructors select six to ten biomedical Capstone projects. The biomedical program typically has 35 biomedical engineering capstone projects each year, most of which are sponsored by external organizations. The sponsor's willingness to participate and the applicability of the capstone topic to a marketing assessment are the largest factors in selecting the biomedical engineering capstone projects. Typically, less complex, consumer-focused projects involving mass-market appeal are selected.

The collaboration is structured so that one team is "primary" (in this case, the marketing team) and the other is secondary, acting as a "sponsor." The primary team is working on the core learning objectives of their course (in this case, the course's cumulative assignment is a marketing plan), and the secondary/sponsor team has minimal activities related to their course (attending meetings and serving as a subject-matter expert). In this case, it means the marketing students take the lead on most of the work, and the engineering students are essentially only responsible for showing up to meetings and answering the occasional email. This expectation also means that the secondary/sponsor teams will meet outside their scheduled class times. On the first day of class, state the expectation for meeting with their partner team, and instructors need to be ready to interpret and be flexible when conflicts take priority, such as another class scheduled during that time. Setting clear roles for the engineering team is important, as their roles are less common in academic settings. They are not responsible or accountable for the marketing team's report. However, the engineering students are responsible for showing up and serving as subject-matter experts for their marketing team. The engineering teams also attend the marketing students' final presentation and provide feedback, acting as their sponsors. The true sponsors of engineering capstone projects often appreciate receiving the marketing reports if students wish to share them. Some sponsors have stated they have gotten value from these marketing reports.

The actual interaction between the student teams occurs during three instructor-scheduled meetings during the marketing classes' class time: a project kickoff, a midpoint check-in, and a final presentation. The marketing team is required to attend, but only a portion of the engineering team is required to attend when class scheduling conflicts arise. The engineering syllabus listed the meeting dates along with participation in these meetings tied to a small part of one of their assignment's final grade. Setting expectations on day one on the engineering class side is critical to maintain engagement.

Reflection: Challenges and successes

Feedback from the projects from both the students and instructors has been generally strong. Students have enjoyed working in their roles, and they have recognized new learning experiences possible from these interactions. Some examples include engineering students realizing key user needs they missed or non-performance-based features (such as price or color selection) that improved their demonstrations in engineering contests. Additionally, there is more overlap between marketing and design than most students perceive, particularly in the concept of user/customer needs. As a result of these collaborations and reflections, several guest lectures have taken place between the marketing and biomedical engineering departments, including a lecture on marketing's role in generating user needs for the engineering design process. The negative feedback received is generally associated with the key learnings listed below, many of which have led to program alterations and improvements.

There have been several key learnings for success along the way to see clear positive results:

- There must be two courses that benefit, one with suitable projects and one with a need for projects
- Similarly, course instructors in both departments must champion the collaboration
- Pre-planning is essential, especially in setting expectations and roles, such as within syllabi or grades
- Two-semester capstones with an initial prototype finished after semester one to ensure there is a clear product started for the marketing team when they start in semester two
- There must be "suitable" projects; ideally, projects that can translate to a product/solution, not too niche where it is hard to postulate a market, and not too technically complex that the market team can understand the product and its value
- Alignment of grades and roles is important; for example, the secondary/sponsor team must not be graded directly by the work of the primary team
- The ideal team size is 4-5 students per team

The first pilot year and its success helped prove the concept, enabling the marketing department to expand the idea of a capstone-like project to most of its graduating seniors. Observational feedback has been very positive. Although empirical feedback was limited, a survey was administered to biomedical engineering students at the end of the project in years 2 and 3. The survey consisted of one question, "Would you suggest we do this again next year?" and a free-response field for comments. Of the 31 responses, 30 (96.8%) said yes. Comments included:

- "This was a great initiative."
- "I enjoyed this collaboration very much, it allow me to see another side of my teams project…"
- "It was cool to see the marketing team's way of thinking and initial thoughts with the process of medical device design."
- "I think the idea could be more beneficial if it were slightly more involved."
- "Some projects are harder to adapt to the collab…"

Additionally, other engineering departments have begun participating in this marketing collaboration, using a structure similar to that described in this paper. We will continue the marketing and biomedical engineering collaboration into the near future.

In conclusion, the inclusion of an ongoing cross-department collaboration in the capstone experience has been an enlightening and worthwhile experience for the department and the students involved. We have learned a great deal and will continue to refine and improve the collaboration. We also expect to continue expanding the collaboration in other ways, including graduate programs.

References

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