Development of a Graduate Project Management Course Where Graduate Students Manage Undergraduate Biomedical Engineering Design Teams (Work in Progress)

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Work in Progress: Development of a Graduate Project Management Course where Graduate Students Manage Undergraduate Biomedical Engineering Design Teams

Introduction

Project management, a course/field that aims to teach students the application of knowledge, skills and techniques to project activities to meet project requirements, is popular among a variety of professions. Project management courses are often taught online, or in short-course format with a series of extended lectures with little to no application.

Emerging evidence from research on teaching methods strongly indicates that active learning methods lead to better educational outcomes than standard lecture methods (Wieman, 2014). Further, it has been shown that a project-based learning approach is effective at teaching project management concepts (Keser and Karahoca, 2010). Building upon these two ideas, we investigated the feasibility of teaching a semester-long project management course with embedded hands-on "management" activities to practice principles of project management.

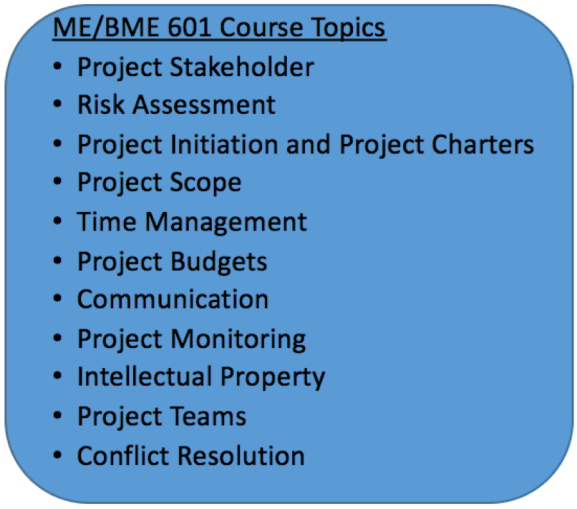

Figure 1: Project Management Course Topics.

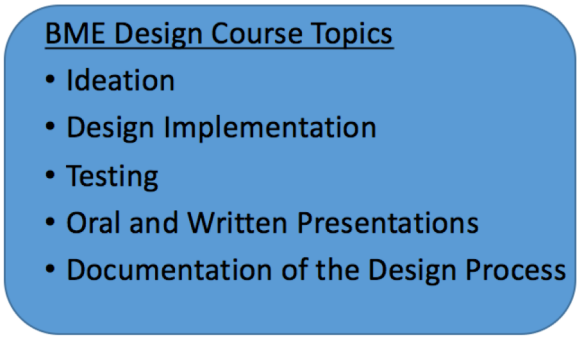

Figure 2: BME Design Course Topics.

Methods

We developed a team-taught, semester-long, introductory project management (PM) course for graduate engineering students. The main objective of the course was to introduce students to the project management process—including project initiation, planning, execution and closure—in a hands-on way. The curriculum of the graduate project management course (Fig. 1) was linked to that of an undergraduate biomedical engineering design course (Fig. 2). In the undergraduate design course, teams of 4 or 5 junior-level students completed client-initiated projects culminating in physical deliverables. During the special semester in which this PM course was piloted, the graduate PM students took the place of faculty and served as design advisors to the undergraduate teams. The graduate PM students were instructed to find a balance between being an observer and an intervener to teams providing guidance, insight, and direction where appropriate. The graduate PM students met with undergraduate engineering design teams once per week and did not have the assistance of teaching assistants in the course.

Tentative Schedule

ME/BME 601 – Project Management, Spring 2016

Week, Date	Topic (Instructor)	Sub-Topic	BME Design Course Deliverable/Activity; Corresponding ME/BME 601 Management Activity
1 1/22	Introduction, Project Management Overview (JD, JT)	• Review of syllabus • Getting to know you • Motivation for course • BME design curriculum • Project definition • Motivation for project management • Project life cycle	BME Design • Team selection, • Project selection
2 1/29	Project Stakeholders (JD)	• Definition and types of stakeholders • Assessment of stakeholders • Determining detail interests of stakeholders	BME Design • Meet client • Learn more about project motivation, intended deliverable • Brainstorm, perform supporting activities HW 1 • Project stakeholder
3 2/5	Risk Assessment (JD)	• Risk types • Assessment of risk • Probability and Impact matrix • Risk Register	BME Design • Literature search • Brainstorm • Product Design Specification (PDS) draft due HW 2 • Risk assessment

Figure 3: Project Management Course Schedule – Weeks 1-3. Weekly topics, subtopics, deliverables for the project management course are listed with corresponding deliverables/activities for the design course.

Lecture material and related assignments in the project management course were deliberately aligned with assignments in the design course to facilitate productive interactions between the PM students and the engineering design students. The project management course schedule listed weekly topics, sub-topics and deliverables for its course and corresponding deliverables/activities for the design course (Fig. 3). For example, during week 2, while the undergraduate engineering design teams considered their clients' needs, the graduate PM students were learning about the related broader topic of stakeholders—all persons and/or groups, not just the client, that have influence over the outcome of the design project. Unlike the engineering design students, the PM students were required to explicitly consider the level and type of influence and expectations of the stakeholders for their associated design teams. The alignment of the deliverables in the PM and engineering design courses created a framework in which each PM student could provide relevant and timely guidance, insight and direction to her engineering design team. The hope was for each design team to be more thoughtful about its project and to generate refined design deliverables (documentation, brainstorming process, final design) through interaction with the PM student.

Brief surveys, consisting of questions rated on a 5-point scale, were administered to the graduate PM students and the undergraduate engineering design students at the beginning and end of the semester to assess achievement of the PM course objectives (Figs. 4, 5).

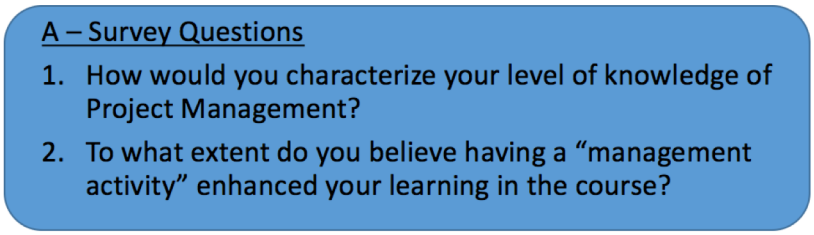

Figure 4: A-Survey Questions. These are survey questions, relating to the extent course objectives were achieved, that were asked of the project management students.

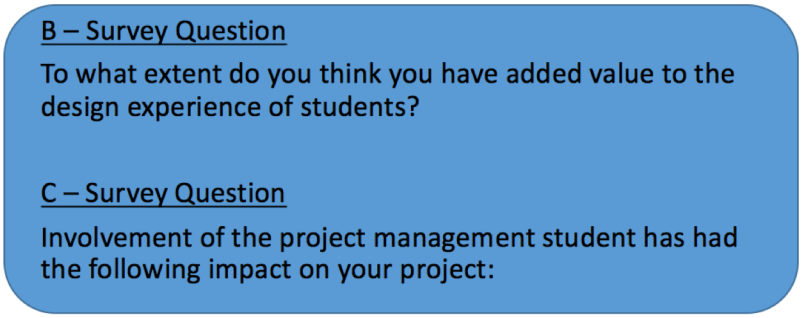

Figure 5: B- and C-Survey Questions. Survey Question B was asked of the project management students. Survey Question C was asked of the engineering design teams. Both questions relate to the novel aspect of the course, i.e., the interaction of the graduate project management students with the undergraduate biomedical engineering design teams.

Results

Seven of nine graduate students (78%) in the project management course and 16 of 36 undergraduate students (44%) in the engineering design course completed the surveys. Project management students reported being more knowledgeable about the topic as a result of the course (mean score changed from 1.4 (week 1) to 4.3 (week 13); 5 = knowledgeable; Fig. 4). They also indicated that having hands-on activities did not hinder but mostly enhanced learning (mean score: 4.29; 5 = strongly agree; Fig. 4). Both the graduate project management students and undergraduate engineering design students believed the impact of the project management students on the design experience of the undergraduate students was only moderate (mean score: 3.1 (project management students); 3.4 (design students); 5 = high impact; Fig. 5) throughout the semester.

Discussion

Comments from graduate project management students suggested that moderate impact on the design experience of undergraduate engineering students may have been due to the misalignment of the syllabus assignments in the graduate course as compared to those in the undergraduate course. Greatest alignment between the syllabus assignments in each course occurred during the ideation design phase of the undergraduate engineering design course (Fig. 2), i.e., the first six weeks of the semester. Beyond that point in the semester, the engineering design students were focused on the implementation and testing design phases while the PM students were focused on such topics as time management, project budget, communication, and project monitoring (Fig. 1). Additional comments from the undergraduate students suggested that the moderate impact on their

design experience was likely due to meeting just once per week to talk about the project. The undergraduates also cited an incompatibility between the syllabus assignments in the graduate course versus their own.

Preliminary work in the design of a graduate-level project management course with embedded hands-on management activities may require more careful design of the course schedule and assignments; as well as planning more meetings with the design students that more realistically mimic interactions between a project manager and her project team. There is no straightforward solution to the misalignment of the course schedules for the project management and design courses. Fully aligning the project management course schedule to that of the design course would require unreasonably compressing the time spent on project management course topics. Future offerings of the course may instead rely on case studies for management activities (e.g., Martens and Carvalho, 2016). Alternatively, the project management course may only enroll the team leads of each undergraduate design team (Dee, 2017). This alternative solution would promote a more seamless integration of the project management skills into the undergraduate design team effort. This approach would also enhance the skillset of the design team lead.

References

Dee, KC. Integration of Project Management Course with Engineering Design Course. J. Towles. Personal Communication. 2017.

Keser H and Karahoca D. Designing a Project Management e-Course by Using Project Based Learning. Procedia Social and Behavioral Sciences 2: 5744-5754, 2010.

Martens ML and Carvalho MM. The Challenge of Introducing Sustainability into Project Management Function: Multiple Case Studies. Journal of Cleaner Production 117(20): 29-40, 2016.

Wieman CE. Large-Scale Comparison of Science Teaching Methods Sends Clear Message. Proceedings of the National Academy of Science USA 111(23):8319-20, 2014.