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Construction Management Curriculum Transformation through Project-Based Learning: Initial Implementation

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Over three years ago, the established Construction Management (CM) program at Purdue University held a faculty retreat to determine "what the curriculum would look like if the department started over". After years of research and planning, the proposed solution of a paradigm shift to vertical and horizontal integration through project-based learning during all four years has come to fruition in its first completely restructured, team-taught course implemented in the spring of 2018. Instruction focused on the targeted American Council on Construction Education (ACCE) competencies and student learning outcomes introduced in the first year of the program. This paper discusses the final planning processes occurring in the fall of 2017 and the actual implementation of the 6-credit hour, team-taught course in the spring of 2018 and will reflect upon the lessons learned during the undertaking of the course.

Key Words: curriculum, student learning outcomes, competencies, project project-based learning, industry engagement

Introduction

Over the past few years, Purdue University School of Construction Management Technology has presented papers on the planning process of this curriculum transformation case study. This paper briefly summarizes the planning portion of this process, but primarily focuses on implementation of the first fully transformed course, a 6-credit hour, team-taught fundamentals course. The purpose of the overall transformation is to integrate all construction management (CM) core classes into larger, project-based courses. This translates the original (20) 2-4-hour CM courses into (one) 3-hour course, (three) 1-hour courses, (three) 6-hour courses, and (four) 9-hour CM courses as can be seen in Figure 1, Course Transformation. The six and nine hour courses are classified as pre-construction (class numbers ending in 0000) and construction (classes ending in 5000) content and increase in difficulty and complexity as the student advances through the curriculum (Santon, Metzinger, Cabral, Benhart, & Morgan, 2017). The purpose of this series of papers, this case study being the implementation phase, is share the policies, procedures, and processes completed to transform what is considered a typical construction management program into a completely project based curriculum.

Literature Review

Construction Management Programs in universities around the world are striving to provide the most up-to-date curriculum as possible. In a survey performed by Ahmed, Yaris, Farooqui, and Saqib (2014), it was found that the best performing construction managers possess "managerial, industry, business, professionalism, legal, contractual technical, and people" (p.244) skills. Although there are many ways to teach these skills, academic institutions are slowly moving from a 'teacher-centered' (such as traditional lectures) approach to include more 'student-centered' approaches in the curriculum. This shift is a response to research on student motivation indicating students are more "motivated to learn things they clearly perceive a need to know," which was sometimes not clearly accomplished in lecture based instruction (Prince & Felder, 2006). Student-centered approaches often include active learning, which encourages students to take ownership of their learning, and teamwork, which is essential for management professions, construction management included. Some examples of instructional methods that are considered

student-centered approaches are: guided inquiry, problem-based, project-based and case-based learning. For a more in-depth review, see Prince and Felder (2006).

For this paper, we will focus on Project Based Learning (PBL). Ideally, in a PBL approach, students are presented with an authentic context project that guides students to inquiry and technical knowledge. Also in PBL, students are usually held accountable to what they produce by sharing their projects as culmination of the learning experience. This means students in PBL settings also learn learn responsibility, independence and discipline, in addition to technical knowledge (Bell, 2010).

Project Based Learning (PBL) is especially suited to be used in the instruction of construction management students, given the project-based nature of the AEC industry (although problem-based and case-based instruction have also been used in construction based courses – see McWhirter & Shealy, 2018 and Nguyen, McIntyre & Diab, 2007 for a case-based and problem-based instructions, respectively, in construction education settings). Studies conducted by Siotiak and Walters (2009, 2013) of construction management students in a senior capstone course that used a project-based (and a hybrid of problem/project based) approach have indicated positive results in terms of improvement of students' leadership skills and other soft skills, such assertiveness. Other previous research in a construction management setting has describe positive results in the use of PBL and integrated curriculum, in order to improve the so called "traditional" construction management curriculum, resulting in positive feedback from students, as well as perceived quality improvement of students' work, as observed by faculty (Barlow, 2011). Therefore, results of the use of PBL in construction management undergraduate education are encouraging, especially when combined with previous research on the desired traits of successful construction managers (Ahmed, Yaris, Farooqui, & Saqib, 2014).

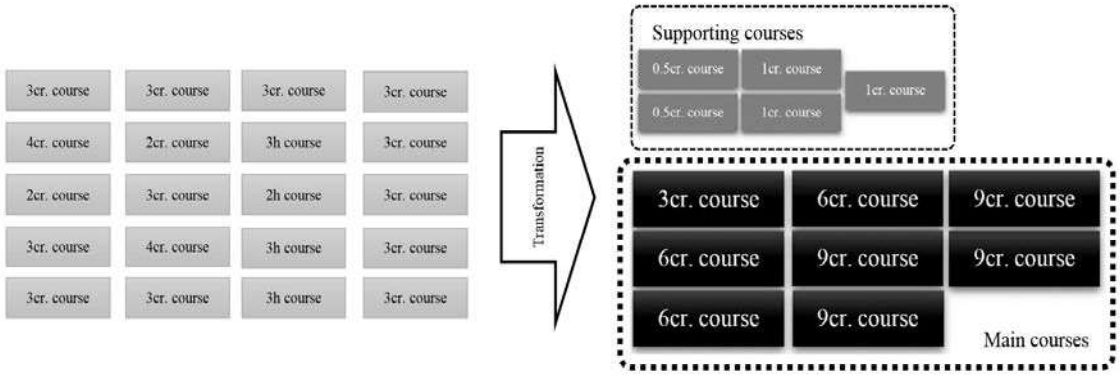

Figure 1: Course Transformation

Summary of Previous Work

The previous papers published on this endeavor focused on the various stages of planning the courses. The first stage focused on making the case for project-based learning (PBL) and finding successful examples of team-taught coursework. Utilizing a PBL pedagogy can enhance several aspects of learning such as increasing soft skills and shifting students from a passive learning structure to an active learning environment (Benhart, Cabral, Hubbard, Metzinger, Morgan, & Santon, 2017) to increase their level of engagement (Rokooei and Hall, 2018). Although no academic program had attempted an integration such as this on throughout an entire program, several prominent programs integrate portions of their program. The curriculum team divided into smaller teams and visited these other programs, including Olin College in Needham, Massachusetts. At the same time, the entire CM faculty broke down their courses into topics and assigned academic level to these topics; knowing that the beginning of a semester may be review from a previous course and by the end of the course the topics may be higher level. The curriculum

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committee then arranged the modules in accordance with the assignments and available time in each new course. Figure 2 shows the original break down of these topics by course, Figure 3 shows the new proposed plan of study with the distributed topics in the transformed courses. Due to student plan of study obligations, the department has to simultaneously run both the "old" and "new" curriculums at the same time to accommodate all students; thus phasing in the transformed curriculum and phasing out the original curriculum. This schedule has been updated based on student needs and can be seen in Table 1.

Because the content was essentially already created, the primary focus of planning was the rearranging and aligning of topics and developing a rich industry project library that could be used within the courses:

> It is vital to ensure that the classes tie horizontally (within year) and vertically (all pre-construction courses align together and all construction courses align together). Although the outcomes and objectives are the same, or in some instances even improved, as the previous curriculum, one of the major differences is the basis of the content: authentic industry projects. Integrating topics such as mechanical, electrical, structural, and cost systems in the same course and from the same plans, specifications, and documentation bolsters students' interdisciplinary skills and knowledge required to manage construction projects. These co-taught courses promote independent learning, critical thinking, and application of knowledge. (Santon, et al, 2017, p. 1)

Figure 3 is the original transformed proposal, but the distribution of topics has evolved since its inception to keep the alignment needed within the curriculum.

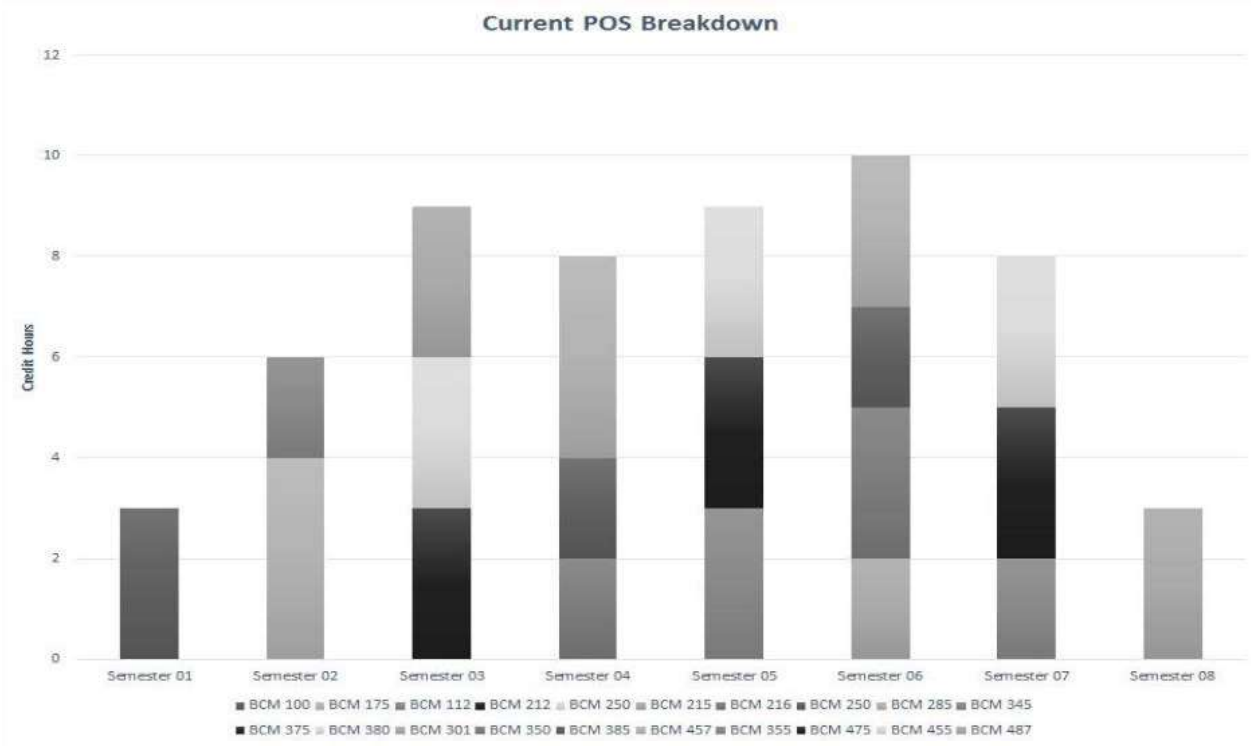

Figure 2: Each Semester Plan of Study by Topic (Original)

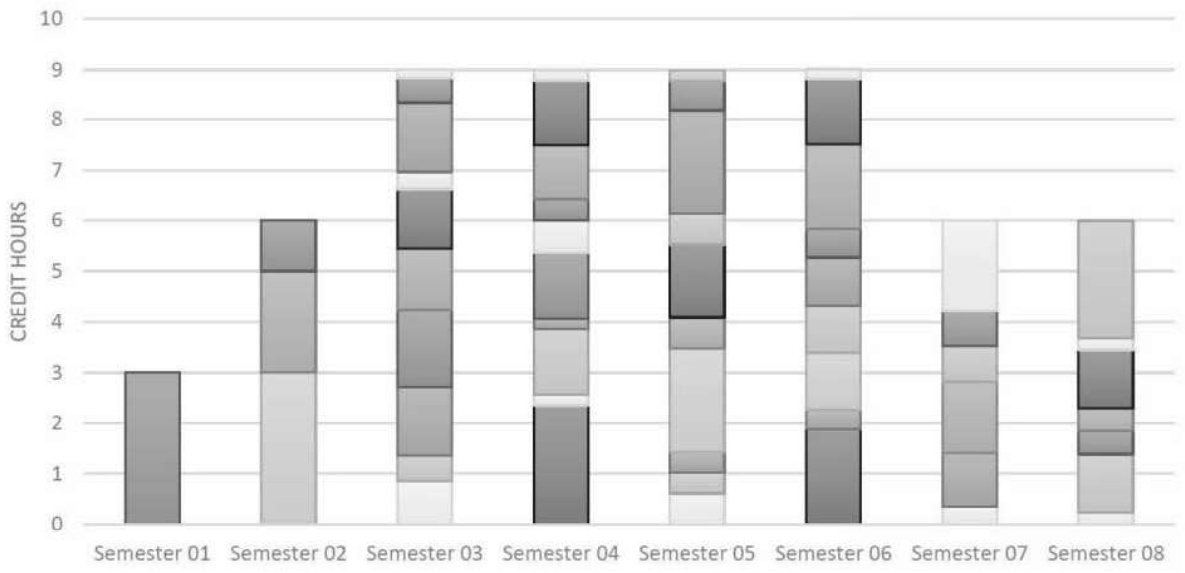

Figure 3: Each Semester Plan of Study by Topic (Transformed Proposal)

CM 15000 Preparation

The 2017 summer and fall were a crucial point in preparation for the CM 15000 class, the first fully transformed class to be implemented. The team of five, a mix of tenure-track professors, professors of practice, and one visiting professor, worked to schedule the course and develop lesson plans. The group started with the schedule, utilizing butcher-block paper and sticky notes, a portion of this can be seen in Figure 4. The sticky notes were color-coded to represent topics in construction history, construction surveying, construction documents, and construction materials and methods. Other color-coding represented outside work assignments, assessments, and simulations. All of the main topics are covered in lecture, lab, homework, and assessment so that learning is reinforced. Further, these topics will be covered at a higher level in the subsequent classes.

An example of a scheduled week can be seen in Figure 5. In this example, the first two-hour lecture covers wood material and floor framing, supports and layout (materials and methods), and the 27 steps of construction developed in Levittown (history). The homework for that day is wood and framing calculations. Preparing for the next day, lab 1, the students, on their own, must watch a floor framing and wood layout instruction layout. Once in lab on day two, they will break into small groups for flooring calculations (materials and methods). To prepare for day three, lecture 2, they must write a professional letter about an interaction at the career fair. For lecture day three, there is a professionalism discussion (documents) and finally a lecture over field communication, mistakes, and errors (surveying). In day four, the lab simulation is that while they are working in a large group for the floor framing, some of the workers are screwing off and not working.

Finalizing the schedule took several months, starting at the end of the spring 2017 semester, working through the summer, until the beginning of the fall 2017 semester. At the same time, the team was sorting through project plans and documents to determine a project that the semester's lessons could focus upon. During the fall semester, lesson plans were developed. Each faculty member focuses on developing lesson plans unique to their expertise and teaching assignment.

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Table 1

Detailed Transformation Schedule

Phase In	New Courses / Curriculum						
	Fall 2017	Spring 2018	Fall 2018	Spring 2019	Fall 2019	Spring 2020	Fall 2020
	CM 10000	CM 11000	CM 20000		CM 30000	CM 45000	CM 43300
		CM 15000	CM 25000		CM 35000	CM 49000	
					CM 39000		
					CM 40000		
					CM 23300		
Phase Out	Current Courses / Curriculum						
	Fall 2017	Spring 2018	Fall 2018	Spring 2019	Fall 2019	Spring 2020	Fall 2020
	BCM 10001		BCM 17500		BCM 21500	No Current Courses	
			BCM 11201		BCM 21601		
			BCM 27500		BCM 25001		
					BCM 28500		

Note: Semester listings are of first offerings of new curriculum courses and last offerings of current curriculum courses

Figure 4: Sample Planning Schedule

Lecture 1	Homewor	Replay	Lab 1	Replay	Lecture 2	Lab 2
Wood Matl, Flr Fram	Calcs	Floor Framing Vid	Small Group for	Write a professional letter	Professionalism Small Act, Lrg Grp	Workers are screwing off, see
Support & Layout		Wood Layout Vid	Floor Formulas	about interaction at career fair	Discussion	how f.m. reacts
Levittown					Field comm,	Large Group Floor
27 Steps of Cons					Mistakes & Errors	Framing (Blr Crib)

Figure 5: Sample Week Module Schedule

CM 15000 Implementation

The CM15000 course was launched and implemented in the spring 2018 semester. The course was a six-hour course that included four hours of lecture and four hours of lab per week; two lab hours are considered one contact hour in the university system. The course met for two hours of lecture Mondays and Wednesdays and two hours of lab on Tuesdays and Thursdays. The course had approximately 80 students who all met together on lecture days and were broken up into groups of approximately 20 for lab days. This schedule can be seen in Figure 6.

	Monday	Tuesday	Wednesday	Thursday
7:30		Lab (group 1)		Lab (group 1)
9:30	Lecture (all students)	Lab (group 2)	Lecture (all students)	Lab (group 2)
1:30		Lab (group 3)		Lab (group 3)
3:30		Lab (group 4)		Lab (group 4)

Figure 6: Sample Week Lecture and Lab Schedule

The team knew this class would be unlike any other the students had ever been, so it was decided that the first week would be a "boot camp" style week to introduce both the topics and class to the students. The first week included introductions into the syllabus, student handbook, course requirements, and expectations such as the attendance policy and communication requirements for attendance. The students were also given a preview of the situations they would encounter throughout the semester, such as small and large group work, history, lab safety, and plans and specifications.

The team was primarily divided into two smaller teams of instruction, two lectures instructors, two lab instructors, and one lab and lecture instructor. Although not every instructor would present every day, each instructor was present for lectures in order to know the instruction for the day and any challenges the students had. All of the instructors met once a week to discuss the flow of the class, any issues with instruction or students, and prepare for the upcoming week.

Lessons Learned

Although the course was successful and was enjoyed by several students, there is always room for improvement, especially for the first presentation of a course. Further, there were several successes within the course. Assignments will be tweaked, dropped, or added.

From a faculty perspective, the first major success was the weekly meetings. These were one hour meetings, held weekly with all instructors involved in the CM 15000 course, for the duration of the semester. The meetings brought the faculty team together into a cohesive group and kept everyone on track. Recapping the week kept topics fresh and helped with content integration, providing weekly lessons learned that will be taken into consideration for the next iterations of the course. However, topic integration could have been improved. For example, in this first

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iteration, the change orders activity (within the documents module) did not fully relate to the materials and methods covered at the same time of the course, missing an opportunity to better integrate the different course modules. Additionally, the team wanted the students to write and reflect more, therefore a daily report was developed for the lab portions of the course, Figure 7, for use in the next course offering.

For the fall of 2018, the course is in its second iteration with slightly different instructor, one instructor left the university and another is teaching other courses; however, the overall structure of the course remains the same. During this semester, the CM 20000 and CM 25000 courses were also launched and will be discussed in a later paper. The transformation continues and will be revised as necessary to accommodate students and provide the best possible courses.

Daily Construction Report

Job No. (Course): _____ Date: _____

Weather: _____ Work Hours: _____

Crew: _____ Equipment: _____

Visitors:

Personnel Absent:

Tasks Completed:

Safety Issues:

Additional Comments:

Name: _____ Signature: _____

Figure 7: Daily Construction Report for Lab Students

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