Mapping the curriculum around student learning outcomes and assessment of learning

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Abstract

This paper addresses efforts by a Construction Management Department to map its curriculum in response to the new ACCE accreditation format focusing on the student and program learning outcomes. The process revolves around providing an answer to four questions: "Are we teaching our students the right thing?", "Are they grasping the concepts?", "How do we measure their learning?", and "How do we document the measurements and continue improving?". The answers to these four questions provide the platform for curriculum mapping and efforts leading to continuous improvement.

Keywords: Curriculum design, Curriculum mapping, Student learning outcomes, Program learning outcomes.

What is curriculum mapping

Curriculum mapping as defined by Koppang (2004) is a method of collecting data about what is really being taught in schools and universities. Hale (2008) states that while curriculum mapping is recognized as a highly effective method for serving students' ongoing instructional needs and creating systemic change, the means for putting this data-based decision-making process into practice may not always be clearly understood. A Study conducted at the University of Connecticut (2000) by Huba and Freed concluded that developing a plan for designing and delivering learning outcomes flows from the top down, i.e. from the overall institution outcomes, to the academic program outcomes, to the course outcomes, to the unit (within the course) outcome and concluding with the lesson outcome, whereas students experience the system in reverse, i.e. from the bottom up. It has been advocated as a method of aligning the written and taught curriculum since the early 1970s. More recent advances in technology have expanded the use of curriculum mapping as a tool for improving communication among instructors about the content, skills, and assessments that are a part of the instructional process. It can be applied at different levels of the instructional process, with the primary goal of covering gaps, and eliminating unintentional duplication.

Need for curriculum mapping

The impetus for mapping the construction management curriculum stemmed from multiple coinciding factors including a progressively evolving body of knowledge, a constant increase in project complexity, an increasingly competitive market working in sub-optimal economic conditions, and a demand for academic reform to produce graduates ready for the job market. The economic downturn and the following recession in 2008 resulted in a slow-down of construction activities on both the regional and

the national, and to a certain extent the international levels, which had a direct impact on the student enrollment in construction management programs. Additional pressure from academia and the need to streamline curricula and reduce the number of credit hours for a construction management degree (120 semester hours in most institutions) led many programs to revise their curricula and look for ways to optimize course design and frequency of offering.

After several years of using a matrix of curriculum topical contents and number of hours of instruction, the American Council for Construction Education (ACCE) started adopting a new model for program assessment and accreditation based on student learning outcomes (SLO). Instead of counting the number of hours covering each of the curriculum topical contents, the focus shifts to what the students have learned, what is the proper mechanism for gauging this learning, and how to document it.

The mapping process followed the SIPOC model (Supplier – Input – Process – Output – Customer), and resulted in a set of documents called course assessment forms representing at the course level: what are the pre-requisite courses and the pre-requisite knowledge needed for this class (supplier and input), what are the learning objectives for this class (process), what are the learning outcomes (output) and what are the following classes in the sequence (customers). A course flowchart representing a career plan was developed, and different mechanisms for documenting and measuring student learning are discussed.

Four questions to be answered

To provide a streamlined curriculum responding to the abovementioned criteria, four questions have to be asked and properly answered:

1- Are we teaching our students the right things (What)?
2- Are the students grasping the taught contents and concepts (How much)?
3- Are we properly measuring their learning (How)?
4- Are we properly documenting the results for continuous improvement (Is it better than the last time it was taught)?

To answer these four questions, the department got immersed into a thorough review of the curriculum, not for the purpose of reinventing the wheel, but primarily for the sake of fine-tuning it, trimming any extra fat (unnecessary duplications), and building bridges among the faculty leading to synergy rather than the smoke-stack syndrome and the separate island behavior resulting in faculty being experts in what they teach but knowing little or nothing out of their sphere of expertise, and certainly not what their colleagues teach. These detailed discussions and the resulting changes provide the participating faculty with a better understanding of the curriculum, a feeling of ownership of this curriculum, and becoming major stakeholders in any decisions made therefore.

Answer to question number one: are we teaching the right things?

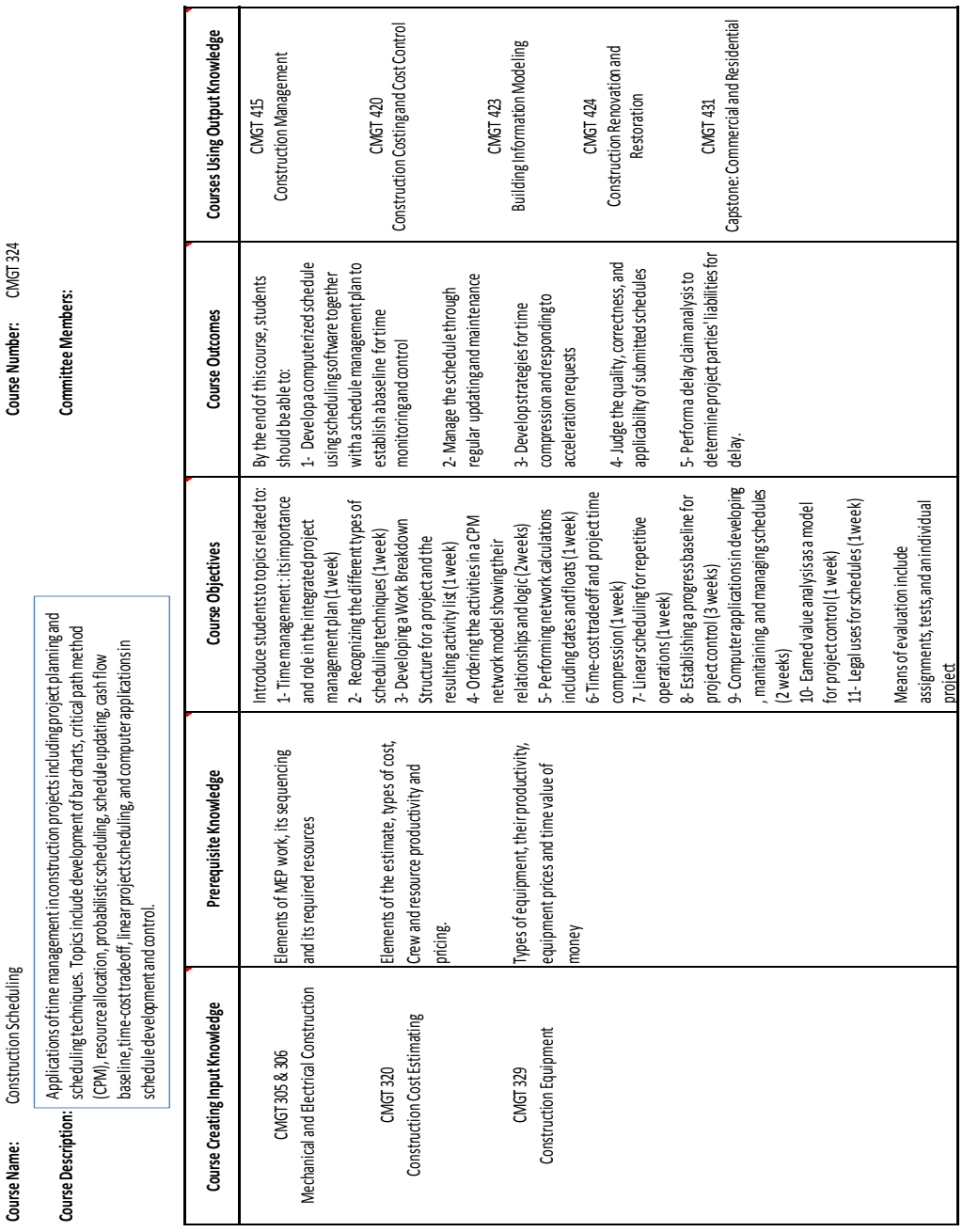
In conjunction with its industry advisory board, the department embarked on a two-way dialogue assessing what is the industry looking for in a graduate from a construction management program, in which direction is the industry moving, and what are the commonly observed

deficiencies in recent graduates from the program. This process took place in small focus groups based on the interest and discipline within the construction industry (residential, commercial, specialty, heavy/civil), and resulted in a set of forms called the course assessment forms as shown in figure 1. The course assessment forms were developed based on the SIPOC model (Supplier – Input –- Process - Output – Customer), that looked at the class sequence and contents, taking into consideration the pre-requisites for each class, and the following classes on the course critical path. This exercise enabled the participants to become deeply familiar with the curriculum composition, its contents, and its sequence, which allows for better allocation and distribution of topics over the different classes. The form included the catalog description of the class, its owners (faculty or team responsible), its pre-requisite classes in the program (Supplier), the gained knowledge from each of these pre-requisites (Input), the student learning objectives for the current class and the method they will be assessed (process), the student learning outcomes from the class (Output), and the recipient class of this newly acquired knowledge (Customer). The development of these forms was done in an iterative process to allow for the proper allocation of topics and matching subject–to-class. The mapping was complemented by a course flowchart reflecting the course sequence and time of offering as shown in figure 2, allowing for the different stakeholders (students, faculty, administrators, employers, parents, etc.) to see a clear road map leading to better planning and resulting in a timely graduation. Uchiyama et al (2009) have stated that creating a visual representation of the curriculum based on real time information is a way of increasing collaboration and collegiality in higher education. On the course flowchart, the core classes were highlighted in red, whereas the technical electives were highlighted in blue, and classes from other departments were displayed in a different color. The solid lines represent pre-requisites, whereas the dotted lines represent co-requisites.

Answer to question number 2: Are the students grasping the taught contents?

To provide an answer to this question, a review of the existing assessment forms was conducted, to determine the best method to measure the student learning based on the designed and expected learning outcomes. Some of the outcomes could be directly measured through assignments, tests and quizzes (direct measures) and could be conducted at the class level, whereas other learning outcomes were progressively developed and would be evaluated at the program level (during the capstone project), or through performance in co-ops and based on surveys and feedback from the industry (indirect measures). An example of the latter includes creative thinking and problem solving skills, communication skills (both verbal and written), and ethical behavior. In some classes, pre- and post-learning assessments were conducted, to identify the type and amount of knowledge students started with, and compared to the amount they ended the class with, with the assumption that the difference represents what they have learned in this particular class. These pre- and post-learning tests served as a confirmation on the sufficiency and quality of the "supply" of knowledge students learned and retained from previous pre-requisite classes, and led in some cases to providing "refreshers" in case of deficiencies. The feedback was transferred to the pre-requisite classes to ensure proper coverage in future offerings of the same class. Other

means of assessing the students' level of understanding of the taught concepts included the "minute paper", where the students were asked in the last five minutes of class to answer questions such as "List the most important thing you have learned today", or "What other questions need to be answered". Another technique was the "muddiest point" as used by Angelo and Cross, (1993), where students were asked to answer to the prompt "the muddiest point about today's lecture was", and if the faculty did not have the time to address these points in the same class, the muddiest points would be the start of discussion in the following class session.



Course Name: Construction Scheduling

Course Number: CMGT 324

Course Description: Applications of time management in construction projects including project planning and scheduling techniques. Topics include development of bar charts, critical path method (CPM), resource allocation, probabilistic scheduling, schedule updating, cash flow baseline, time-cost tradeoff, linear projects scheduling, and computer applications in schedule development and control.

Committee Members:

Course Creating Input Knowledge	Prerequisite Knowledge	Course Objectives	Course Outcomes	Courses Using Output Knowledge
CMGT 305 & 306 Mechanical and Electrical Construction	Elements of MEP work, its sequencing and its required resources	Introduce students to topics related to: 1- Time management : its importance and role in the integrated project management plan (1 week) 2- Recognizing the different types of scheduling techniques (1 week) 3- Developing a Work Breakdown Structure for a project and the resulting activity list (1 week) 4- Ordering the activities in a CPM network model showing their relationships and logic (2weeks) 5- Performing network calculations including dates and floats (1 week) 6-Time-cost tradeoff and project time compression (1 week) 7- Linear scheduling for repetitive operations (1 week) 8- Establishing a progress baseline for project control (3 weeks) 9- Computer applications in developing , manitaining, and managing schedules (2 weeks) 10- Eamed value analysis as a model for project control (1 week) 11- Legal uses for schedules (1 week) Means of evaluation include assignments, tests, and an individual project	By the end of this course, students should be able to: 1- Develop a computerized schedule using scheduling software together with a schedule management plan to establish a baseline for time monitoring and control 2- Manage the schedule through regular updating and maintenance 3- Develop strategies for time compression and responding to acceleration requests 4- Judge the quality, correctness, and applicability of submitted schedules 5- Perform a delay claim analysis to determine project parties' liabilities for delay.	CMGT 415 Construction Management CMGT 420 Construction Costing and Cost Control CMGT 423 Building Information Modeling CMGT 424 Construction Renovation and Restoration CMGT 431 Capstone: Commercial and Residential
CMGT 320 Construction Cost Estimating	Elements of the estimate, types of cost, Crew and resource productivity and pricing.			
CMGT 329 Construction Equipment	Types of equipment, their productivity, equipment prices and time value of money			

Figure 1 – Course assessment form

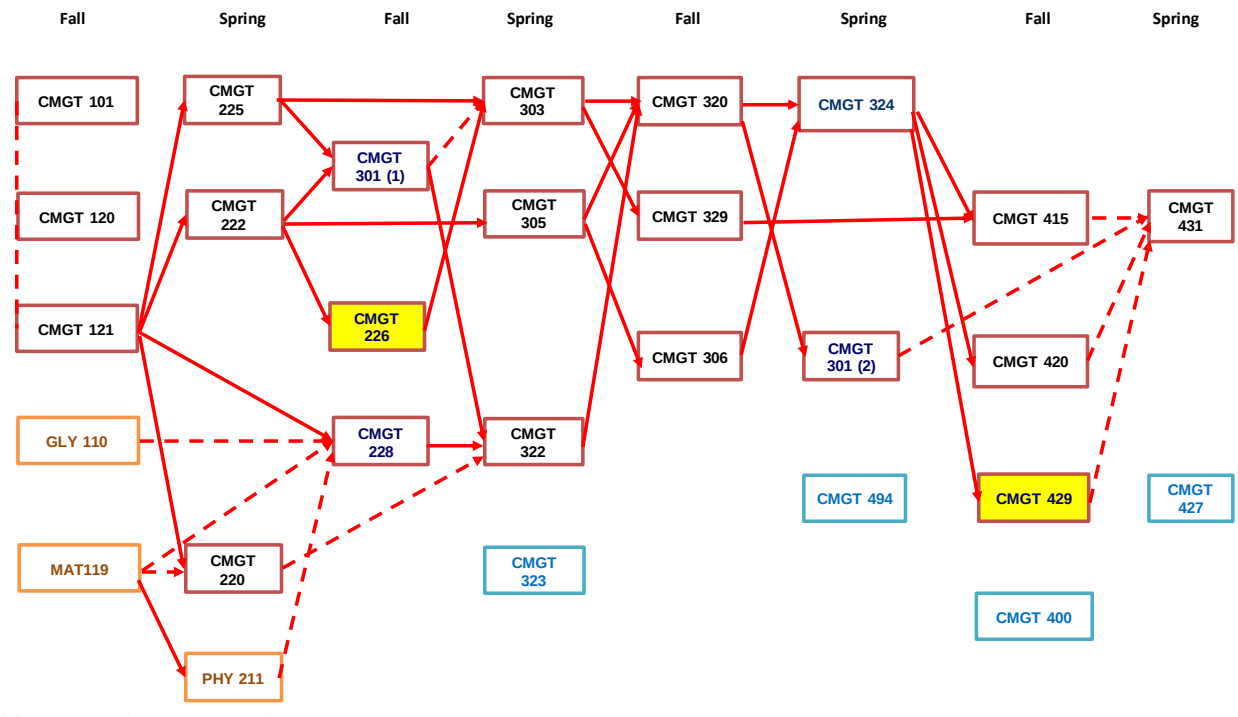


Figure 2 – Course flowchart

Answer to question number 3: Are we properly measuring their learning?

Linking learning outcomes to learning objectives was performed at the syllabus level as a plan, with an interim review as the semester progressed by regularly comparing the students' answers on tests, quizzes, assignments and projects to directly correlate the taught contents and concepts to the student performance on these contents and concepts, thus allowing for a higher level of definition and focusing, as a control measure, on the learning experience in a qualitative and quantitative way. As a program, an internally developed assessment exam administered at the graduating seniors' capstone class allowed for a comprehensive review of what the students have learned, and retained till their graduation. The department plans to move in fall 2014 to the nationally administered AIC exam as one of the utilized tools to gauge not only student learning and retention, but also their relative performance compared to their peers at the national level, together with statistics on individual student performance and the areas of deficiencies to be addressed in future iterations. Although the AIC exam is a widely adopted tool for assessment of learning, the department chose to use it as "one of the tools" and not the "exclusive tool", as some of the learning outcomes cannot be directly measured through the test (e.g. electronic elements including: design and drafting, contract administration, scheduling and estimating among other things). Other assessment tools included exit surveys prior to graduation, and a one-year employment survey addressed both to the graduates and to their employers one year after graduation.

Answer to question number 4: Are we properly documenting the results for continuous improvement? (Is it better than the last time it was taught)

The department started documenting student learning through an electronic portfolio (Saad et al., 2003) in the form of a PowerPoint shell that the students had to populate with their deliverables from different courses including assignments, projects, reports, etc. This electronic portfolio was developed by the department and made available to the students to customize based on their own preference, and included active links to the different courses, and links within each course showing its different expected assignments, reports, projects, etc. Upon completion of each one of these deliverables, students had to hyperlink them to the shell, and submit the completed shell at the end of each semester on a flash drive to the class instructor for evaluation and assessment. Upon completion of their 4 year degrees, students would have a complete chronology of their educational experience in an electronic format allowing for easy storage and retrieval, and serving as an electronic business card for each student that can be used for promoting their skills to prospective employers. The portfolio served another purpose to the faculty and the department administration: it allowed for both horizontal and vertical tracking of instruction quality and completeness. In the horizontal direction, each faculty would review the deliverables hyperlinked to the portfolio and compare them to the learning objectives for the class, and all instructors had access to these portfolios, ensuring that students would come to the instructor's class with the expected proficiency and proper level of knowledge from the previous classes. In the vertical dimension, each instructor could compare the historical progression of their classes, making sure new developments are incorporated and that the class keeps abreast of technological advancements and is not static or stagnant. Figures 3 and 4 show screens from the student portfolio

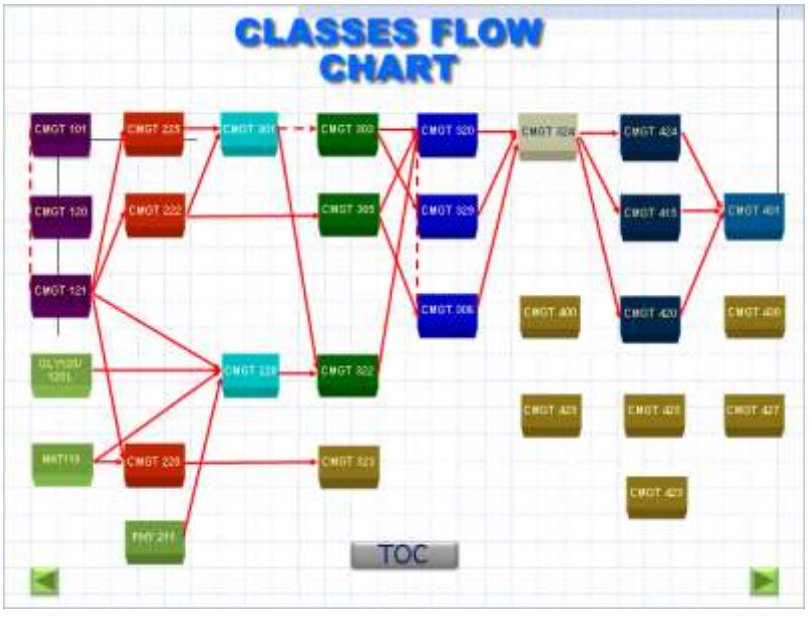


Figure 3 – Hyperlinked Shell for the Portfolio and Table of Contents

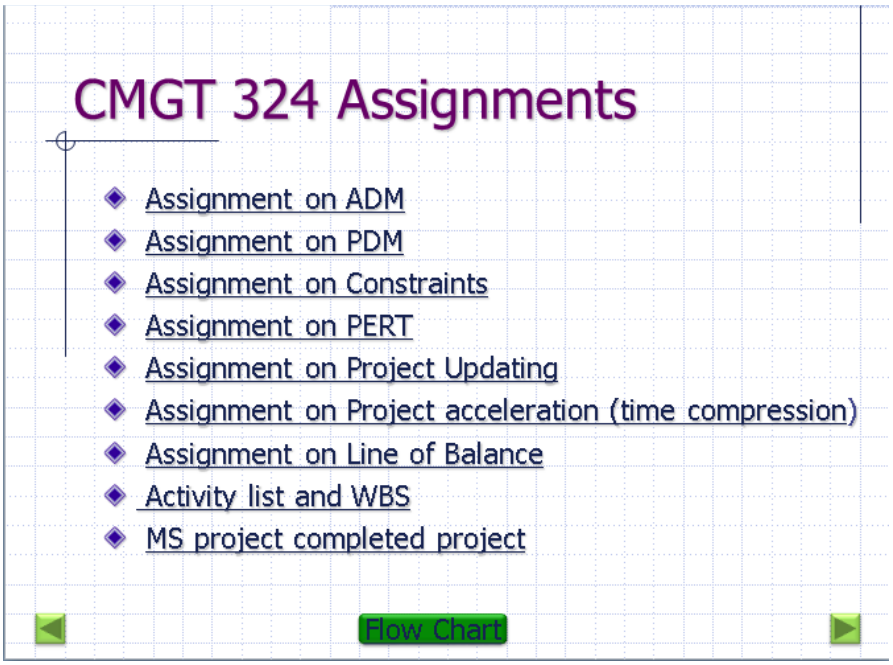


Figure 4 – Sample Class Deliverables

Conclusion

Curriculum mapping can be a worthwhile exercise uniting the faculty and informing each instructor on the other elements of the curriculum he or she is not directly involved with. With the rapidly progressing state of the construction industry and the incorporation of new methods, techniques, materials, and approaches to managing the construction project, such an exercise become necessary on a regular basis (no more than 5-year intervals) to ensure that the program is up-to-date and is meeting the learning objectives for students and expectations of the industry. Faculty involvement and buy-in are integral factors for the success of the implementation of the mapping process. Individual faculty preferences and comfort zones can be negotiated for the sake of the common good and to guarantee the optimum learning experience for the students. The feedback from such mapping and its impact on student performance will take time to gauge, starting with a 1 year survey to recent graduates and employers and another survey to the same groups sent five years after graduation.

Preliminary results indicate better course alignment and redistribution of topics among courses to better prepare students for upper level classes, resulting in more time for these upper level courses to address materials at a deeper level of coverage, yielding a higher level of learning on the Bloom's taxonomy exhibited through more "evaluation and creation" than "remembering and understanding". Annual reviews of the portfolio contents continue to be performed and compared, and fine-tuning of the program based on the feedback remains, and will remain, a work-in-progress. It is impractical to assume that such an effort will be conducted without a certain level of resistance; as it requires in many cases expanding a faculty member's repertoire,

and taking some faculty members out of their comfort zone in an attempt to try new approaches and adapt to new technology and keep abreast with a fast-paced industry. The curriculum mapping process and its different steps of development was discussed at its different phases of development with many of the external stakeholders, represented by a very involved industry advisory board, thus gaining their support and confidence, resulting in more opportunities for students to perform co-op training during their studies, and translated in more (quantitative), and better (qualitative) job offers for graduates recruited at higher starting salaries than in previous years (12% increase on average).

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