AC 2010-1391: SINGLE SYNERGISTIC COURSE VS. MODULES IN MULTIPLE COURSES

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Single Synergistic Course vs. Modules in Multiple Courses

Abstract

The obvious possibility of future CE accreditation requirements associated with the Body of Knowledge (BOK Version I) during the fall 2008 accreditation visit cycle and the corresponding development of a new Civil engineering program with its first ABET visit scheduled for fall 2008 motivated the new faculty team to initiate an effort to develop a BOK I compliant program for its first accreditation visit. The new Civil Engineering program requirements surrounding leadership, public policy and administration, business practices, asset management, and an additional science appear to be daunting at first glance. When the programs on campus with courses containing the required content were contacted to possibly team teach a course with these topics (exception being the additional science) or help produce modules to be inserted into existing courses, the faculty refused to work together to team teach a course with the resounding reason - how to possibly manage the work load model! There was also no inherent benefit to developing content to be delivered by others or themselves as a subject matter expert for a two to nine lesson block of material.

The civil engineering faculty were undaunted and decided to develop a single course to mesh the topics of leadership, public policy and administration, business practices, and asset management during the senior year with all other senior level courses in the new program being taught for the first time. This action also corresponded with the record year for the upcoming ABET visit. The thought was to develop the content, teach the course, assess the results, determine improvements and make the improvements as part of the program/course assessment process and present as part of the continual assessment plan in the self-study report. The course content, the assessment of results analyzed, and the assessment of the improvements instituted during the second offering of the course will be presented. Additionally, the invaluable synergism between topics in this course and the senior design experience will be highlighted.

Some of the content in this course will eventually migrate to other courses in the curriculum as they mature such as the movement of public policy content into the introduction to environmental engineering course which is only being taught this year for the second time. Once this occurs, the use of the single course incorporating all of these topics might not be needed, but most likely there will be new requirements from BOK Version II that will need to be integrated and quite possibly this single course can continue to synergistically integrate these multiple topics across the entire senior level curriculum. Additionally, the coverage of these topics as multiple modules in a single course or spread between many courses will be discussed as a methodology into how one program is looking at meeting ABET accreditation requirements for students seeking an accredited degree at the masters degree level without an accredited degree at the bachelors degree level.

1.0 Introduction

The American Society of Civil Engineers (ASCE) has recognized the lack of certain knowledge and skills among recent graduates, while at the same time engineering programs are facing pressure to decrease credit hour requirements in undergraduate curriculums. ASCE formed a committee to study and develop a Civil Engineering Body of Knowledge (BOK)[1] to document the requisite knowledge, skills, and attitudes necessary for future civil engineers. Two key areas associated with the BOK was a definition of expected performance levels by these new engineers through Bloom's taxonomy[2] as well as the addition of four new outcomes focused on additional professional topics and discipline depth. Very quickly it was determined by most programs and ASCE that the discipline depth could only occur at the Master's level. The additional professional skills above what even ABET[3] EC2000 requires reflect greater recognition of the importance of the development of professional skills at the time of bachelor's level graduation. How/Where are these supplementary professional topics to be included in the current curriculum?

The ABET[3] EC2000 professional skills are demonstrating professional and ethical responsibility (3.f), engagement in life-long learning (3.i), function on a multi-disciplinary team (3.d), communicate effectively (3.g), and apply knowledge of contemporary issues (3.j). These topics are sometimes relegated to the senior seminar during the last semester before graduation if formally covered at all. Should programs simply lump the new CE program criteria professional requirements in with the efforts to meet the current ABET (3.d, f, g, i, j) professional topics?

Another question that seems to be pertinent before answering the previous questions is how do students learn best? There is much research and discussion on the topic, but most educators generally agree that students learn best anything that they experience themselves as well as normally do repetitively. Many engineering educators have homework, design projects, and mid-term exams, and many times topics are tested again on a final exam. This process allows the student to first wrestle with the concept at their own pace in a homework assignment where they can collaborate with others before being asked to test their skills within a timed event such as an exam. Learning by doing is the primary basis behind the growth of project-based learning (PBL) opportunities.[4] Some programs have been completely sold on the concept to the point of desiring PBL for all learning activities within the program.[5,6] These collaborative, team design experiences allow even deeper understanding through group work focused on a project. If this process is sound, then why are many professional topics relegated to single activities in a seminar course, not being tested at all or students just being asked to know they exist? If only required within the senior design team experience, it is possible that only the student assigned to write up the team experience (if a requirement at all) will wrestle with the topic.

How does a program add the new topics? The Department of Civil Engineering at The University of Texas at Tyler which is the newest program to be added to the College of Engineering and Computer Science began hiring faculty and admitting students in 2005. The students who made up the first graduating class in 2008 were actually admitted into the mechanical engineering program in 2004 with the anticipation of hiring the first CE

faculty member. There were twelve students who declared themselves as future Civil Engineering (CE) students before the department officially existed. This placed these students on a path to graduate in May 2008. The timing could not have been better considering that the next scheduled ABET visit for UT Tyler was fall 2008 because of the previous accreditation visit in 2002 for the electrical and mechanical programs. A program cannot be considered for accreditation if they do not have at least one graduate at the time of the visit by ABET. Therefore, the program needed at least one of the twelve students to make it to graduation and demonstrate accomplishment of the program outcomes! With the assessment process only beginning in spring 2007, the program teaching its senior courses for the first time during the ABET record year (2007-2008), and the senior seminar a college-wide course which includes ME/EE students that do not have the same program requirements, the program needed to come up with a rapid solution to guarantee demonstration of the professional outcomes.

The professional topics emanate from Outcomes 4, 6, 7, 8, and 9 of the UT Tyler CE Program Outcomes (PO) presented in Table 1 which are derived from ABET Outcomes (3.d), (3.f), (3.g), (3.h), (3.i), and (3.j) in Table 2 and the CE program criteria. PO 9 specifically incorporates the new undergraduate professional requirements located within the CE program criteria. The difficulty arises in how do students demonstrate or fully understand what these outcomes are asking when the demonstration is possibly left to a single event within the senior year. These professional outcomes have been referred to as "soft" outcomes by many when they were first presented as part of ABET EC2000 Criterion 3. Others have used the word "squishy" when considering how difficult it is to assess professional skills compared to the "hard" skills of engineering.[8] "Soft" or "Squishy", the professional skills are not as easily assessed and many times require multiple assessment methods, multiple activities within the academic setting as well as activities like Engineers Without Borders or other service activities to be able to properly demonstrate accomplishment of the outcome.[7] Another example of the difficulty is that students may properly assess a situation based on proper ethical reasoning, but there is no assurance that they will actually act ethically. Some define professional skills as how we perform in professional settings, but how do educators develop and assess such skills?

Table 1 UT Tyler CE Program Outcomes

Graduates:
1. Apply knowledge of traditional mathematics, science, and engineering skills, and use modern engineering tools to solve problems.
2. Design and conduct experiments, as well as analyze and interpret data in more than one civil engineering sub-discipline.
3. Design systems, components, and processes and recognize the strengths and areas for possible improvement of their creative designs within realistic constraints such as regulatory, economic, environmental, social, political, ethical, health and safety, constructability, and sustainability.
4. Work independently as well as part of a multidisciplinary design team.
5. Identify, formulate, and solve engineering design problems using engineering models in the four of the five sub-disciplines civil engineering: structural engineering, transportation engineering, construction management, hydrology and/or environmental engineering.
6. Analyze a situation and make appropriate professional and ethical decisions.
7. Demonstrate effective oral, written, and graphical communication skills.
8. Demonstrate a commitment to learning and continued professional development outside the classroom,

incorporate contemporary issues during problem solving, and determine the impact of engineering solutions in a global and societal context.
9. Explain professional practice attitudes, leadership principles and attitudes, management concepts and processes, and concepts of business, public policy, and public administration.

Table 2 ABET Criterion 3 (a-k)

Demonstration (incl. Process & Measurements) that Graduates have:
(a) ability to apply knowledge of math, engineering, and science
(b) ability to design and conduct experiments
(b) ability to analyze and interpret data
(c) ability to design system, component or process to meet needs within realistic constraints such as regulatory, economic, environmental, social, political, ethical, health and safety, constructability, and sustainability.
(d) ability to function on multi-disciplinary teams
(e) ability to identify, formulate, and solve engineering problems
(f) understanding of professional and ethical responsibility
(g) ability to communicate effectively
(h) broad education
(i) recognition of need by an ability to engage in life-long learning
(j) knowledge of contemporary issues
(k) ability to use techniques, skills, and tools in engineering practice

2.0 Solution

The ABET professional outcomes (3.d) multi-disciplinary teams, (3.g) communicate effectively, (3.i) life-long learning, and (3.j) contemporary issues were being addressed in other courses and would be readdressed within the upcoming senior design. ABET outcome (3.h) broad education was addressed within the confines of the healthy CORE (44 credit hours) at the UT Tyler. ABET Outcome (3.f) professional and ethical responsibility would be addressed in the senior design, but could students miss fully understanding and demonstrating this outcome since all of the work is completed in teams? What about the three new outcomes covering topics of leadership, public policy and administration, business practices, and asset management?

UT Tyler's Civil Engineering Program solution: a new course added to the curriculum to ensure coverage of the professional topics in the title as well as other professional skills at a time when the program was teaching its senior level courses for the first time during the ABET record year (2007-2008). The new course was CENG 4341 Leadership, Public Policy, Business Practices, and Asset Management which would provide coverage of the three new outcomes in the BOK which are represented by program outcome 9 as well as demonstration of parts of Outcomes 6, 7, and 8.[9] Formal assignment of embedded indicators to courses based on perceived ability to demonstrate an outcome to include CENG 4341 provided the best odds at being BOK compliant and passing the ABET visit. The result – the program received no deficiencies and no weaknesses.[10] CENG 4341 synergistically assisted students in seeing the big design picture and the nuances of teamwork, leadership and management required in the two-semester senior design (CENG 4115/4315) by analyzing and discussing solutions to leadership issues seen during the one credit hour CENG 4115 in the fall, public policy affecting engineering projects in East Texas, and business practices that could constrain their capstone project

design as well as how well they have been managing their personnel assets within their team. Even though the CE program desires for public policy to be eventually covered in the introduction to environmental engineering, the program needed immediate coverage since CENG 3371 Introduction to Environmental Engineering was being taught for the first time during Spring of 2009 (after the fall 2008 visit) and CENG 4371 Environmental Engineering Design which had to cover introductory topics as well as design until CENG 3371 was being taught (too much content) was being taught for the first time during the ABET record year (spring 2008).

CENG 4341 is comprised of four modules each with papers and an exam leading to a comprehensive final exam. The original idea was to draw upon the expertise across campus and have the individual teaching a course covering the topic to develop a 10 lesson block with an exam. The length of each module was a quarter of the course which seemed reasonable considering the current focus of the course. Topic order was not important since each expert would teach their block (i.e., team teaching). When the issue of how to give credit to a teacher for one-fourth of a course became a stumbling block, the author decided to develop each block himself. Since now one teacher was going to teach all four blocks, the author decided to draw on the order of topics to develop a richer experience as well as provide linkage to additional professional topics. Upon reflection, it was obvious that all of the professional topics focus on the engineer being a leader within their firm - so it was covered first. Public policy affects a firm's business practices and it takes leaders within government for public policy to be enacted. So it was taught next followed by business practices. Business leaders must understand public policy processes so that they can influence the process as appropriate. The key focus in small business practices (a large number of civil engineering firms are considered small) is the development of a business plan which is affected by public policy and the leaders within the firm. Once the business plan is in place, it once again requires leaders to manage firm assets to accomplish assigned tasks and missions to meet the desired level of business performance.

2.1 Data collected

During the 2007-2008 assessment cycle (the UT Tyler ABET record year), every assignment of the new course CENG 4341 Leadership, Public Policy, Business Practices, and Asset Management could have been designated as an embedded indicator (Table 3) to cover the new professional skills listed in the CE program criteria. Embedded indicators are assigned to each course to ensure adequate demonstration of outcomes (e.g., Table 4, example of the data collected for a portion of Outcome 9 for the ABET self-study). Only a few assignments were selected initially as embedded indicators within CENG 4341 to limit how much a single course needed to provide to the assessment process. The embedded indicators were assessed and filed into a notebook for each outcome.

2.2 Analysis of the data

Even though there were a limited number of collection opportunities within the curriculum, the analysis of embedded indicators collected by outcome at the end of the 2007-2008 assessment cycle showed that the professional outcomes were generally covered through the embedded indicators within CENG 4341 Leadership, Public Policy, Business Practices, and Asset Management, the senior design sequence, construction management and environmental engineering design. The professional outcomes focused on public policy, leadership, contemporary issues, and the impact of solutions were better addressed in the senior design spring semester (Spring 2009) because of the detailed coverage in CENG 4341 during the fall semester.

Table 3 Embedded Indicators in CENG 4341

Assignment	**Outcome**
Paper 1 – define your leadership skills and attitudes.	9b - Leadership
Paper 2 – define your leadership goals while an intern using appropriate leadership theories such as equity, expectancy, etc.	9b - Leadership
Paper 3 – define your leadership strategies for ensuring your Capstone team is successful.	9b - Leadership
Exam 1, problem 1, define and explain leadership using appropriate theories	9b - Leadership
Paper 4 – Define public policy while considering T. Boone Pickens and West Texas Water rights	9e – Public Policy
Paper 5 – define and provide the pros and cons for wetland public policy	9e – Public Policy
Presentation – 10 minute presentation on what can the do as part of policy alternatives.	9e – Public Policy
Exam 2, problem 1, define and explain public policy using appropriate theories	9e – Public Policy
Paper 6 – define a business plan through the eyes of an junior engineer	9d – Business
Paper 7 – explain how you would improve the efficiency of asset use within the company you worked for this past summer	9c – Management
Exam 3, Problem 1, define and explain business practices	9d – Business
Exam 3, Problem 4, Define and explain asset management though lean six sigma and waste limitation	9c – Management
Final Exam, Problem 1, explain leadership using theory and examples	9b - Leadership
Final Exam, Problem 2, explain public policy using theory and examples	9e – Public Policy
Final Exam, Problem 3, explain business practices using theory and examples	9d – Business
Final exam, Problem 4, explain asset management using theory and examples	9c – Management

Table 4 Assigned Embedded Indicators Completed

Outcome 9c: Can explain management concepts and processes.		
Direct Measures	Standard	2007-8 Performance
CENG 4339, Final Exam, Question #27 (cradle to grave management)	80.0	100
CENG 4341, Final Exam Question (Lean Six Sigma, Eliminate waste)	80.0	81.7

The students felt that their understanding of these professional topics improved due to their coverage in a course versus being lumped onto the senior design experience which is already busy and has many moving pieces. The discussions in class on defining these skills, how these skills were applied first in their internships and analysis of their supervisors and companies, and then applying their understanding to their senior design teams improved their understanding and use of the newly acquired skills. Figure 1 displays the Fall 2007 (071S) data of the students perception of how well they understood and demonstrated the new CE program criteria. Student comments pointed out the need to increase the number of papers (smaller length) to allow greater specificity for each paper when wrestling with the numerous topics within the course. They also asked for case studies and guest speakers.[11] The suggestions were applied during the next offering of the course with the resulting improvements (081S, Figure 1). Additionally, it must be noted that teaching the course the second time could have had some effect on the results.

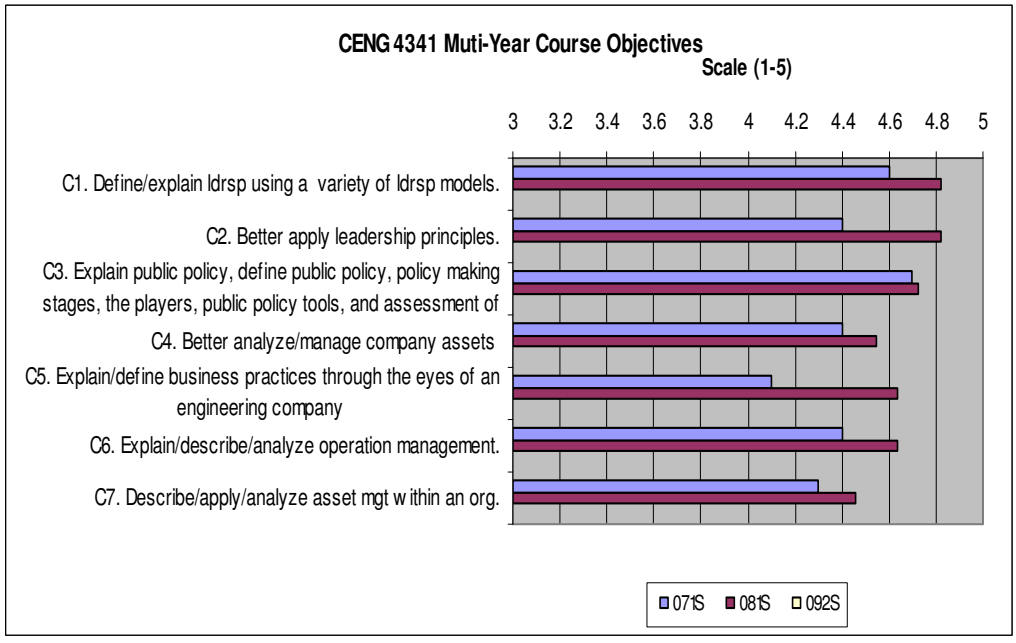

Figure 1 CENG 4341 Course Objectives Assessment

CENG 4341 is not your typical junior/senior level civil engineering course that is very technically oriented. In fact, there is not anything beyond the discussion of previous use of project management tools that could be considered technical. Additionally, most

engineers detest writing so the method of assessment of papers and presentations is not a favorite among the students. So one might expect that the assessment of how well the teacher did in the classroom might suffer as well. Figure 2-3 depict the teacher's performance for the first and second year the course was offered. Figures 4-5 depict just how the course compared with all the courses offered within the civil engineering department. Almost all of these courses are technical in nature – which draws most students to engineering in the first place. The University and College are preparing institution wide questions similar to the ones presented in Figure 2. The questions in Figures 2 and 3 complete a review of a teacher's performance based on the ExCEEd teaching model.[12] As can be observed, this single course bringing together multiple topics can be successful in not only meeting accreditation requirements, but can allow deeper connection between multiple courses and repetitive coverage and assessment of critical "soft" skills called for by ASCE.

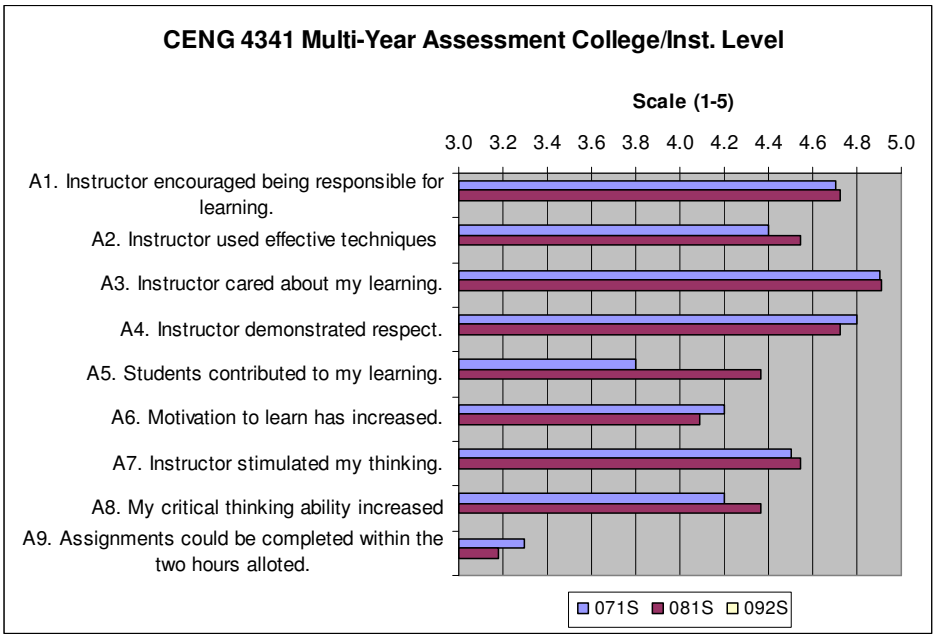

Figure 2 Teacher Assessment at College/Institution Level Questions

There is a concern within the program about the grading load as the program grows. Currently, there are only 17 students in the course. What happens when there are over 40 students in the course? The current junior and sophomore year groups have over 40 students in each. The author has already enacted actions to control the amount of grading by having page length requirements as well as developing grading rubrics that greatly decrease time spent on each paper while providing detailed feedback to each student. A key element is determining the improvement of student understanding within each topic area. Growth in each area can be easily measured by performance on the first paper to the last paper based on what the students must discuss in each paper. For example, the students start by defining their leadership style in the first paper while defining their personal leadership strategies for their senior design team. Each student demonstrates a limited skill within the first paper and greater skill appreciation and readiness to apply in the last paper.

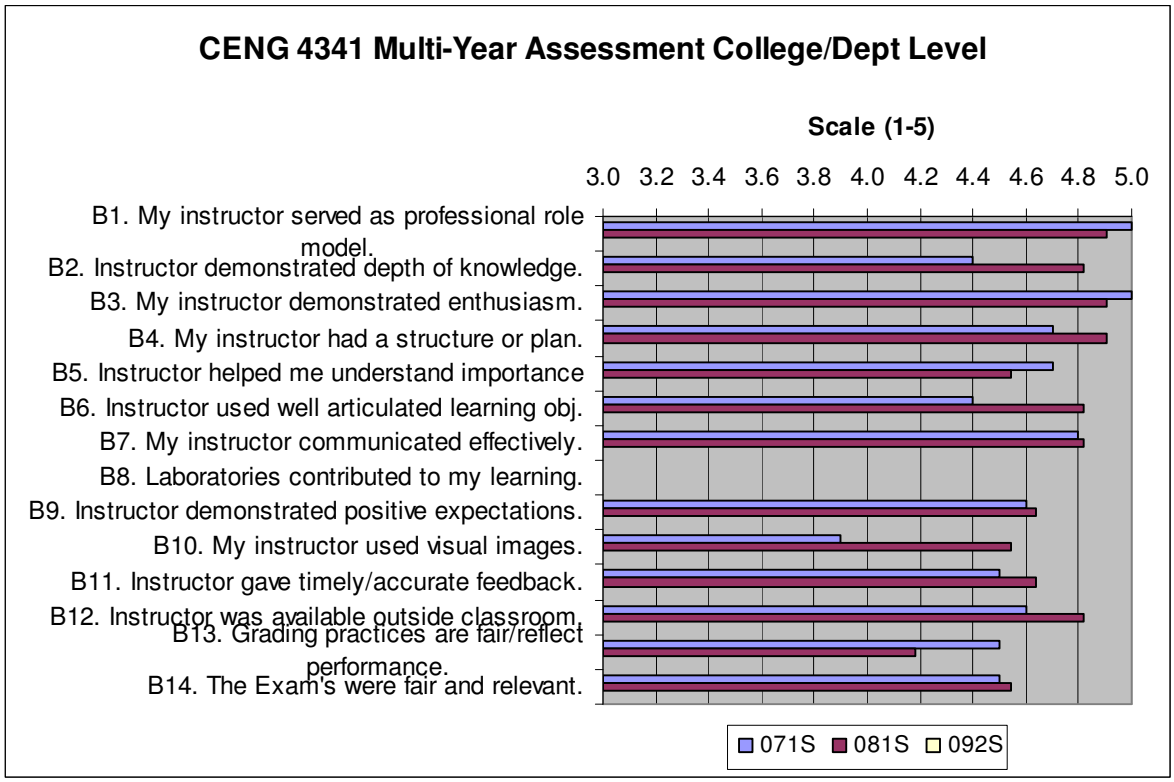

Figure 3 Teacher Assessment at Department Level Questions

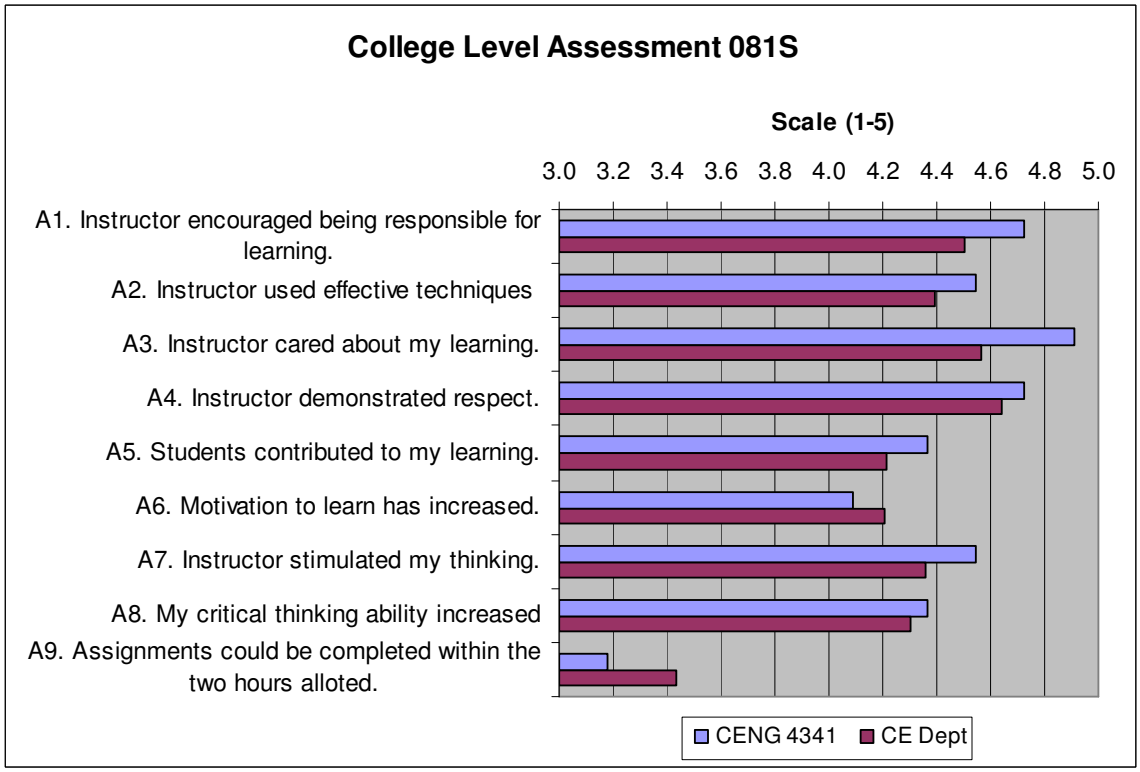

Figure 4 Comparison of Course versus Department

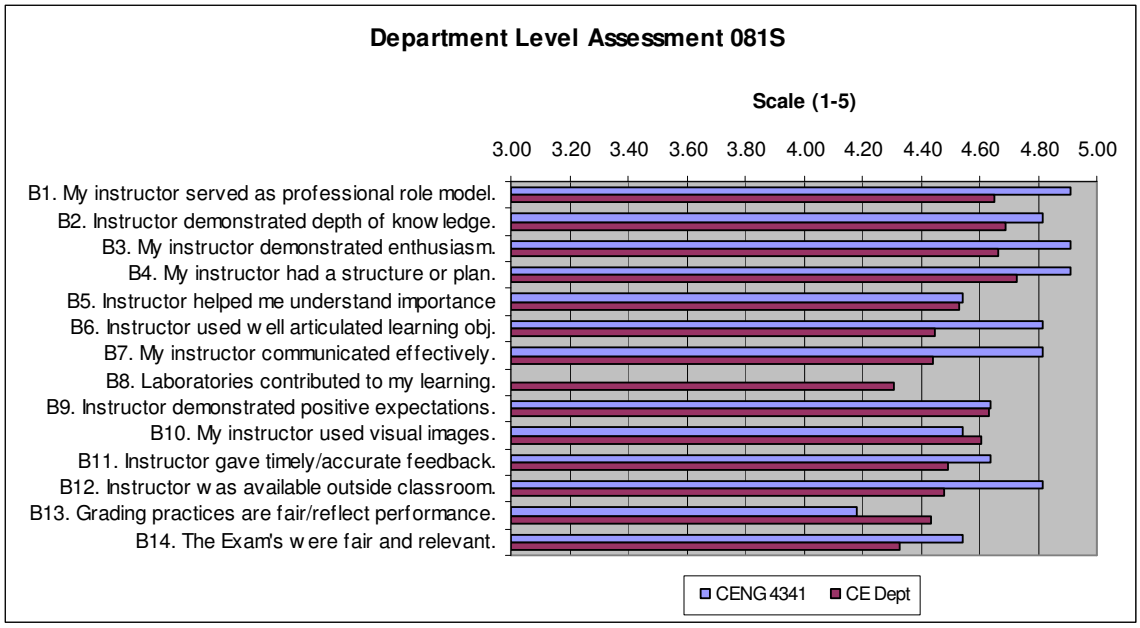

Figure 5 Comparison of Course versus Department

2.3 Analysis of the steps taken, sustainable?

The analysis of the embedded indicators collected for professional outcomes 6, 8, and 9 (Table 1) were few and some were not good demonstrations of accomplishment of the outcome mostly due to the lack of faculty understanding of how these indicators should be demonstrated. Even though the analysis of outcome notebooks was completed by a two faculty member team who reviewed each outcome notebook of embedded indicators and made suggestions as to which embedded indicators to keep, which to drop and what additional activities and possible courses to provide better embedded indicators, if they did not truly understand what the outcome meant, how could they truly make an evaluation of what is provided and make suggestions for improvement. The first step was an in-depth discussion during a department meeting (May 2008) of what each professional skill outcome meant to the faculty team and how best to assess them. With a new understanding, the teams reviewed their work and determined that few of the professional skill outcomes truly were adequately demonstrated. Many professional outcomes only had two embedded indicators, and the FE does not really address them. Surveys are not the most ideal method of assessment, but are they the best at determining whether graduates have the required professional skills (if the graduate and employer understand what the outcome is asking)? Unfortunately, the program has only two groups of alumni who graduated within the last 18 months and surveys traditionally have a low response rate. Therefore, the faculty team decided that there was a need for additional embedded indicators for professional skill program outcomes to fully demonstrate accomplishment of each outcome prior to graduation to enhance the student's first exposure to some of the professional topics in the ENGR 1200 course, Engineering Methods (Freshman Engineering Experience).[13]

What the program has seen is that once faculty are convinced that they need to assess each course assignment and exam to ensure that each graded requirement is accomplishing the desired result, the entire program assessment process is sustainable. If faculty are already assessing a course requirement, then the assessment of the assignment or the portion of the assignment to be used as an embedded indicator for a program outcome is just an extension of something they should already be doing. The faculty team must determine what course each academic year is the best suited to assess professional outcomes so that the students wrestle with each skill at least once each year. If the faculty team can ultimately boil down the number of embedded indicators to the irreducible minimum resulting in an equal spread of embedded indicators across each course, then the associated tasks are really a few additional minutes on top of the course tasks the faculty should already be doing.[10] The ultimate goal is for seniors to demonstrate accomplishment of professional topics through acquired knowledge and skills along the entire academic path.

3.0 Results

The experiment was a success. The new program was able to adequately demonstrate knowledge, skills and attitudes associated with professional topics demonstrated within CENG 4341, the senior design experience and other senior year courses for the current graduating group. However, the ABET Program Evaluator possibly could have found fault if the program was a more mature program and presented the same data and results. The program has begun to fully integrate professional topics across the curriculum and has already seen improvement in student skill development with this group of seniors as compared to the previous graduating classes. The students are simply more comfortable with using their new skills. The CE program has determined that the best method to integrate and assess demonstration of professional skills is to insert embedded indicators in appropriate courses, but only after in-depth discussion among the faculty as to what the professional outcome is asking demonstration of. Actual requirements to consider defined professional skills are needed within the sophomore and junior years, while the seniors must address the professional skills within the 10, 35, and 100 percent submittals.

The review of embedded indicators collected through May 2009 resulted in a thirty percent increase in embedded indicators for the professional topics (Table 5 vs. Table 4). The key has been identification of required embedded indicators for each course before the assessment cycle begins and for each faculty member to establish which assignments before the semester begins will include demonstration of program outcomes, but especially professional outcomes like leadership, the impact of engineering solutions, consideration of contemporary issues, etc. Adequate thought is required to craft assignments that not only demonstrate course objectives that feed seamlessly into demonstrating the “hard” outcomes like design, modern tools, etc., but also demonstrate consideration of “professional” outcomes.[14]

Table 5 Current Assigned Embedded Indicators

Outcome 9c: Can explain management concepts and processes.			
Direct Measures	Standard	2007-8 Performance	2008-9 Performance
CENG 4339, Final Exam, Question #27 (cradle to grave management)	80.0	100	81
CENG 4341, Final Exam Question (Lean Six Sigma, Eliminate waste)	80.0	81.7	94.5
CENG 4339 Project Delivery System	80.0		99
CENG 4339 Project Scheduling Plan	80.0		87.2
CENG 4341, Exam 3, Question 3 Lean Six sigma applied to a scenario	80.0		88.8
CENG 4341 Paper Asset Management – apply lean six sigma and waste reduction	80.0		89.3

4.0 Current actions

The faculty team remains vigilante to push each other to stay focused on the embedded indicators assigned to their courses and that they establish and live the plan of assignments that include embedded indicators.

They also decided to move CENG 4341 Leadership, Public Policy, Business Practices, and Asset Management to spring semester of the senior year and move CENG 4371 Environmental Engineering Design to the fall semester of senior year. This move allows for a better coverage of environmental design prior to taking the Fundamentals Exam (statistical data from NCEES pointed this as needing improvement) as well as produce better discussions of leadership during the senior design since the senior teams will have spent the fall semester working and sometimes failing within the current team structure. The leadership traits and actions used by each member of the senior design team during the fall semester along with those demonstrated by their supervisors when an intern can be properly analyzed and catalogued for future use. Additionally, new leadership techniques can be employed during the remainder of the spring semester. The next offering of the course (spring 2010) will determine if the desired results are met.

The faculty are investigating the movement of Public Policy coverage to CENG 3371 Introduction to Environmental Engineering since much of environmental activity is grounded in past and present public policy. Additionally, the current level of Bloom's taxonomy for these three outcomes is Explain (PO 9, Table 1)[3] which could be covered by 2-3 lesson blocks rather than the current use of a 10 lesson block. The current question before the faculty: should the faculty remove the current course, insert the current content into existing courses using smaller blocks of time or smeared across a course, and add another technical elective since the current program has limited electives available?

Review of the BOK II shows an increase in the bloom's level expected for some outcomes. Leadership and management outcomes have moved upward from Explain to

Apply which might require more time to properly cover the topic. Additionally, there are a few new outcomes that might eventually show up within the civil engineering program criteria such as coverage of Material Science (Apply), a Historical perspective (Apply), Risk and Uncertainty (Apply), and Attitudes (Explain). Material Science and Risk and Uncertainty coverage would most likely be added to a current technical course and a Historical perspective and engineering Attitudes should be spread across the curriculum, but where should the students be held accountable for demonstrating accomplishment? Risk and Uncertainty could be covered in CENG 3371 Introduction to Environmental Engineering or any one of the senior design courses. Since each student must demonstrate accomplishment of the outcome and students can select three design courses from a list of four, unless each covers risk and uncertainty to the same level, some student experiences may be lacking. Logically, the coverage should start in CENG 3371 and finish in the two semester senior design experience. This begs the question, is there enough room now to also include coverage of public policy in CENG 3371? The faculty currently believes that the answer is no, but the in-depth discussion and need for flexibility led the team to decide that placement and coverage of these "soft" topics within technical courses based on the course's focus should be accomplished within a finite set of connected lessons. This methodology will allow modules to be moved between courses without affecting the overall course structure or focus, while providing the program flexibility to meet defined outcomes as the technical body of knowledge advances and faculty skills improve. Currently, a final demonstration of historical perspective and engineering attitudes will be added to CENG 4341 while being assessed as well in the senior design experience.

5.0 Masters' Level Accreditation

Now that the prohibition on dual level accreditation has been lifted for civil engineering programs, the civil engineering program has been asked by their Dean to investigate how best to ensure graduates of the master's level program meet ABET accreditation requirements.

Currently all masters level graduate students within the program have graduated from ABET accredited undergraduate programs; therefore, the program only must demonstrate Technical Specialization. What about students who do not graduate from an ABET accredited program? Should programs turn those students away or do we require a student to complete the ABET accredited undergraduate degree before completing the graduate program? The solution is partially demonstrated by students who graduate from an ABET accredited undergraduate program and take courses within four sub-disciplines of civil engineering as required by civil engineering program criteria, but desire to focus their graduate level studies within one of the other three sub-disciplines of civil engineering. Programs require leveling courses to develop the necessary skills with those students prior to them taking the desired graduate courses.

Since the UT Tyler civil engineering program must currently track the completion of leveling courses, the faculty decided that they should simply expand the matrix to include the tracking of completion of modules (and associated assignments/exam questions) that might be inserted into technical courses. Since many of the professional skills are the

newest additions to the body of knowledge, it is likely that many graduate students coming from non-ABET accredited programs will not have taken any courses demonstrating these skills. One of the leveling courses would be CENG 4341 Leadership, Public Policy, Business Practices, and Asset Management since the course covers a number of outcomes. Additionally, some of the courses currently used to meet coverage of outcomes might be different when it comes to these graduate students since the state requirements are more specific at the Bachelor's level (i.e., large Core requirement – two US history courses, two government courses, etc.).

The initial effort to develop the matrix of coverage of BOK II outcomes is shown in Table 6. The level of detail is whether a course or a module within a course is required. Just as experienced and presented above of how to provide adequate recognition of the work (workload model) provided within a team taught course, how does a student pay for the modules they must take to accomplish a BOK complaint graduate degree? A question for another day…

Table 6 Outcome Matrix versus Course or Module

Outcome	Course or Module
Foundational	
Mathematics	CALC I, II, II, Diff Eqns
Natural Sciences	Chemistry, Physics, Additional Science
Humanities	
Social Sciences	
Technical	
Materials Science	CENG 3434 Materials, Codes, and Specifications
Mechanics	CENG 2301 Statics, CENG 3306 Mechanics of Materials, CENG 3310 Fluids
Experiments	CENG 3434 Materials, Codes, and Specifications
Problem recognition and solving	Four of the following: CENG 3351 Transportation, CENG 3361 Hydrology and Hydraulics, CENG 3371 Introduction to Environmental Engineering, CENG 3325 Structural Analysis, CENG 3336 Geotechnical Engineering, CENG 4339 Construction Management
Design	Two of the following: CENG 4412 Steel/Concrete Design, CENG 4371 Environmental Engineering Design, CENG 4351 Transportation Design, CENG 4381 Foundation Design, and capstone experience CENG 4115/4315 Senior Design
Sustainability	Module in CENG 3371, module in CENG 4115/4315 Senior Design
Contemporary Issues and Historical Perspectives	Module in CENG 4341 Leadership, Public Policy, Business Practices, and Asset Management, CENG 4315/4315 Senior Design
Risk and Uncertainty	CENG 3371 Introduction to Environmental Design or CENG 4412 Steel/Concrete Design

Project Management	Module in CENG 4341 Leadership, Public Policy, Business Practices, and Asset Management, module in CENG 4339 Construction Management
Breath in CE	Four of the following: CENG 4412 Steel/Concrete Design, CENG 4371 Environmental Engineering Design, CENG 4351 Transportation Design, CENG 4381 Foundation Design, CENG 3361 Hydrology and Hydraulics
Technical Specialization	Graduate program
Professional	
Communication	English I and II, paper and presentation in each graduate course
Public Policy	Module in CENG 4341 Leadership, Public Policy, Business Practices, and Asset Management
Business and Public Administration	Module in CENG 4341 Leadership, Public Policy, Business Practices, and Asset Management
Globalization	Senior Design, Module in ENGR 4109 Senior Seminar
Leadership	Module CENG 4341 Leadership, Public Policy, Business Practices, and Asset Management, CENG 4115/4315 Senior Design
Teamwork	CENG 4115/4315 Senior Design, projects in senior level design courses (CENG 4412, CENG 4351, CENG 4371, CENG 4381, etc.)
Attitudes	Module in CENG 4341 Leadership, Public Policy, Business Practices, and Asset Management, CENG 4115/4315 Senior Design
Lifelong Learning	Projects in senior level design courses (CENG 4412, CENG 4351, CENG 4371, CENG 4381, etc.), CENG 4115/4315 Senior Design
Professional and Ethical Responsibility	Module in CENG 4341 Leadership, Public Policy, Business Practices, and Asset Management, CENG 4115/4315 Senior Design

Of course this begs the question, what about the student who does not want an ABET accredited degree since they do not desire to become a professional engineer? The program is discussing the need to have two different Masters level graduate programs. Both will require leveling courses for the technical specialization, but the ABET accredited Masters level program will require documentation of course content and experiences or additional leveling courses or modules that are required to demonstrate accomplishment of each ABET undergraduate outcome.

6.0 Conclusions/Lessons Learned

The faculty team must determine together the courses that should be able to provide an embedded indicator for each program outcome. However, this is usually not enough; each professor must also develop a plan before the semester starts as to which assignments

within the course will contain an embedded indicator. If the plan is not fully developed prior to the start of the semester, the normal day-to-day activities may (usually will) inhibit quality development of embedded indicators or prevent collection of embedded indicators that leaves some program outcomes without adequate demonstration of accomplishment. This is especially true for some of the professional outcomes which appear harder to demonstrate than other outcomes.

The UT Tyler Civil Engineering program successfully implemented a single synergistic course CENG 4341 Leadership, Public Policy, Business Practices, and Asset Management which included multiple modules to demonstrate many of the professional outcomes. The offering of this course along side of the senior design allowed for the students to wrestle with the concepts using their senior design experience as the focus. The single course provided a rapid solution to properly demonstrate multiple outcomes that do not naturally align with traditional technical courses. The experience has also enlightened the faculty to the possible use of modules to successfully level graduate students desiring an ABET accredited graduate degree without graduating from an ABET accredited undergraduate program. Further refinement is required as the program moves forward with accreditation of its graduate program.

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