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A Methodology to Align Student Learning Outcomes with Degree Program Curriculum using Priority Mapping and Coursework Hours

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Among the goals of the accreditation process are to ensure a high level of degree program quality to students and the public. One mandate of accreditation requires a process of continuous improvement based upon the collection, analysis, and resultant action plans of Student Learning Outcome (SLO) assessment data. Because degree programs have a limited number of curriculum hours available for degree-specific learning, an educational unit must determine how to efficiently utilize this resource for student success to demonstrate mastery of specific SLO skill sets. This paper outlines a methodology that includes ranking the SLO's by priority, determining the number of classroom hours taught per SLO, and creating a comparative baseline of the alignment. Analyzing this data creates an opportunity for an educational unit to make data-driven decisions justifying future actions of curriculum changes and fulfills the continuous improvement requirement. The results of using this methodology identified multiple misalignments in SLO priority ranking versus the classroom hours taught, and corrective actions were taken. This successful outcome indicates that this methodology is a viable process to create a framework for analyzing current curriculum time commitments compared to the input of faculty and industry support members ranking the importance of various mandated skill sets.

Key Words: Accreditation, Continuous Improvement, Student Learning Outcomes, Curriculum, Curriculum Alignment

Background and Introduction

The act of granting a degree program official recognition that it meets, maintains, or exceeds minimum standards of quality is called Accreditation (Happe, 2015). The Council for Higher Education (CHEA), defines the role of accreditation to provide: degree program quality assurance to the students and public, qualify the institution which allows students to seek federal student loans, instill confidence with private sector employers seeking to assist with employee tuition, and ensure credit transferability between institutions of higher learning (Eaton, 2006). There are five different approaches to the accreditation process (accreditation.org, 2020):

1. Minimal Model – provides a prescription for a minimal core and general parameters for the remaining curriculum.

2. Peer Review Model – is a coalition of equally similar schools organized into a group for peer-to-peer self-accreditation.
3. Program Club Model – is similar to the peer review model, but takes it one step further to create an accreditation body.
4. Regulatory Model – is a process-based approach and requires strict adherence to a core curriculum and involves the direct prescription of curriculum and faculty composition.
5. Outcomes-Based Model – is a Student Learning Outcome (SLO) based approach and requires the collection of assessment results, measurement against assessment goals, and evidence that the results have been used to foster a quality improvement process.

The latter two approaches are the most common methods of structuring degree program accreditation. The process-based Regulatory Model is often referred to as prescriptive and is further defined as requiring educational units to offer a given set of topics, in a sequence, with a set minimum number of instructional hours per general educational and core subject matter categories. This accreditation method is considered input-based, faculty-centered, and lacks mandatory accountability and coordination by the education unit on its curriculum. It uses the overall course grades as the performance measure with the assumption that a passing grade implies proof that students have obtained competency of the course content. Conversely, Outcome-Based Model accreditation requires an educational unit to demonstrate that students have acquired certain skill sets known as Student Learning Outcomes. This process is learning-based, student-centered, and is dependent upon student outcomes (Ewell, 2001). The trend to move away from the processed-based Regulatory Model towards the Outcome-Based Model, centered on performance-based measuring criteria, has gained significant momentum (Harden, 2007) for all accreditation bodies.

Learning-Based Outcomes models are established upon Bloom's Taxonomy, which was created to place educational goals into specific categories to construct a framework for the assessment of higher-educational learning. In 2001 Bloom's original taxonomy was revised to better define the 6 levels of learning by using verbs instead of nouns. The lowest level starts with Remember and increases through Understand, Apply, Analyze, Evaluate, and peaks at Create. Graphically these levels are represented in a pyramid format to illustrate that learning builds upon learning; these are known as Bloom's Levels of Thinking. Further, Bloom's taxonomy is divided into three learning domains of activities: skills/psychomotor, attitudes/affective, and knowledge/cognitive. Psychomotor is the development of manual and physical skills, affective is the student's feelings or emotions about the subject matter or themselves, and cognitive is the acquisition, retention, and use of knowledge. (Persaud, 2018). This framework of placing educational goals into specific categories represents a learning journey that starts with mastering important baseline knowledge, progresses through the learning levels, and concludes by students demonstrating higher degrees of cognitive processing. To achieve the efficiencies of Bloom's Taxonomy framework, an educational unit must understand the order and action verbs of the learning pyramid, along with the domain of learning activities when defining their degree program SLO's and evaluating their curriculum.

One of the many associations to follow the trend of adopting the Outcome-Based Model is the American Council for Construction Education (ACCE). The ACCE is an accrediting body for construction management, construction technology, and construction science programs across the United States. In Fall 2016, the ACCE transitioned to the outcomes-based accreditation model with the introduction of 20 mandatory SLO's. These SLO's are based upon the use of Bloom's Taxonomy levels of learning within the cognitive domain. The ACCE's significant change in the accreditation process has required construction programs to rethink how they teach, assess, and continuously improved student learning (Bugg, 2019). A step in the process is for the educational unit to define their interpretation, or meaning, of the SLO's. This is a requirement of the ACCE, but the standards lack any guidelines to fulfill the requirement. A proposed process includes input from industry experts, alumni, and faculty to define the SLO using jointly identified essential performance criteria (Leathem, 2020). Construction programs must map their existing prescriptive-based curriculum to an outcome-based curriculum, focused on the new student learning outcomes (Saad, 2014). A component of this mapping process is the collection and review of the existing curriculum to discover what is currently being taught across an entire degree program (Koppang, 2004). Construction Management programs are further challenged to keep up with the ever-changing construction industry, requiring educational units to investigate and incorporate effective industry practices into the curricula (McCall, Wetzel, Leathem, Collins, 2019). Understanding these industry trends and construction employers' input towards these 20 Student Learning Outcomes are essential to discovering philosophical priorities between academia and the industry (Lee, Jeffreys, Ponton, Choh, 2011). The development of a quality assessment program in compliance with these new ACCE standards is a significant change in academic philosophy that many construction management programs struggle to implement (Batie, 2018). These are many of the challenges that an educational unit must consider as part of its required Quality Improvement Plan (QIP) per the ACCE's Document 103B, Standard 9.

Objectives and Methodology

The objective of this paper is to describe and demonstrate a methodology that provides a simple framework and process for an educational unit to create an alignment baseline for the analysis of its current curriculum content hours against its faculty's and Industry practitioner's perceived importance of the SLO's. This framework is intentionally constructed to be generic, allowing its application to any type of degree program with Student Learning Outcomes. This methodology attempts to answer the following questions for an educational unit:

1. SLO Ranking – is one SLO more important than another?
2. Touch Hours – how many classroom contact hours are devoted to each SLO skill set?
3. Alignment – how well do the SLO rankings align with the Touch Hours?
4. Improvement – how can this information be utilized by the educational unit to make data-driven decisions for curriculum modifications as part of its continuous improvement process?

Implementation of this methodology has three distinct steps to create the baseline data for analysis. They are the SLO Priority Ranking Survey, the SLO Curriculum Touch Hours Survey, and the Alignment Table. This study uses the 20 Student Learning Outcomes mandated by the ACCE Standard 3.1.5 of Document 103B. The resulting data, analysis, and a summary of the actions taken are from its application to the California State University, Chico's Construction Management program.

Step 1: SLO Priority Ranking Survey. The SLO Priority Ranking Survey focused on the relative importance, or priority, of an individual SLO over another. This survey was administered using an anonymous online survey and was issued to members of the Chico State Construction Management Department Industry Advisory Council (IAC) and current faculty members. The survey provided the participates with two key pieces of information: The SLO number and name, along with the educational unit's definition, or interpretation, of the 20 SLO's. These definitions were created collaboratively between faculty and the IAC members in 2016. The definitions used Bloom's Levels of Thinking framework to ensure the definitions were taxonomy accurate. Survey participants were asked to "Rank the SLO's in order of perceived importance" using the SLO definitions and their industry experience as guidelines. A 5-point Likert Scale ranging from 1 as "Not Important at All" to

5 as "Highly Important" was the assessment measure. The faculty and IAC data were converted using a weighted average and recorded from the highest-ranked SLO priority to the least.

Step 2: SLO Curriculum Touch Hours Survey. The SLO Curriculum Touch Hours Survey focused on the number of instructional hours taught in individual courses assigned one or more SLO's per the educational units Introduce – Reinforce – Direct Assessment (I-R-DA) map, as required by ACCE Standard 3.1.6.1 of Document 103B. The survey was administered using a shared master spreadsheet that listed all the required degree program courses and the 20 SLO's in a matrix format. Faculty members were instructed to use SLO content I-R-DA mapped topical content outlines to determine the touch hours per class meeting and per SLO. Faculty were also instructed to document the classroom touch hours used for non-SLO curriculum content. This step created the baseline of "Where are we now?" in terms of the number of classroom hours dedicated to teaching assigned SLO course content per the I-R-DA map. The touch hours per SLO were added together and ranked from the most touch hours to the least.

Step 3: The Alignment Table. The results of Step 1, the highest-ranked SLO priority to the least, and Step 2, the most touch hours to the least, were recorded in a table. Another column was added that determine the spread between these two data sets and created the alignment table for analysis and potential curriculum action planning.

Results

The total participates involved in Step 1 and Step 2 surveys are shown in Table 1 and included 37 individuals and took place in 2018. Respondents were limited to the Chico State faculty and members of the Industry Advisory Council (IAC). Comparatively, a similar survey was conducted across the United States by an ACCE task force in 2012. The total participates of this survey are also shown in Table 1. The total participants were 305 individuals from 42 Universities and their IAC members. The purpose of this survey was to determine a prioritized set of 20 Student Learning Outcomes for the ACCE to convert their accreditation standards from prescriptive-based to student learning outcome-based. (Burt, Batie, Burns, Fletcher, Harris, Schmidt, 2013).

Table 1
Survey Participants Data

Sources of data n = number of respondents	ACCE National Respondents	Chico State Local Respondents Step 1	Chico State Faculty Respondents Step 2
Faculty Respondents	n = 130	n = 10	n = 10
Industry Respondents	n = 175	n = 27	
Total Number of Respondents	n = 305	n = 37	
Data Demographics	Diversified across the United States	San Francisco Bay Area and Northern California	San Francisco Bay Area and Northern California

Step 1 Results: The Chico State SLO Priority Ranking Survey data is shown in column 4 of Table 2. The ACCE SLO Priority Ranking Survey results are shown in column 2 of Table 2. Although the purpose of the ACCE survey was for different reasons than this study, it provides an opportunity to

compare columns 2 and 4 of Table 2 and the differences based upon the local demographic results against the national demographic results. While these results are similar, the local results are additionally influenced by the educational unit's SLO definition bias and other items unique to the degree program. In contrast, the national results provide a diversified average of SLO rankings across the United States. This data is relevant to a degree program and what makes it unique.

Step 2 Results: SLO Curriculum Touch Hours Survey are shown in column 6 of Table 2. The total Touch Hours per SLO are shown in column 5. The number of touch hours not associated with any SLO curriculum and the total number of instructional hours are at the bottom of this column. These non-associated hours provide an opportunity for reassignment to SLO-specific content.

Step 3 Results: The Alignment Table is shown in column 7 of Table 2 and was derived by subtracting column 4 from column 6. The results of this column demonstrate that the degree program's Curriculum Touch Hours are not aligned with its SLO Priority Ranking Survey results. An analysis of column 7 reveals six SLO's with double-digit misalignment differences and another four SLO's with misalignment differences over 5. These misalignments may be the result of many different possibilities including dated curriculum content, remnants of prescriptive-based accreditation structure, failure to acknowledge proper taxonomy for assessments, and depth of knowledge, among others. This data column provides an opportunity to individually identify the reasons behind the misalignment for each SLO, have meaningful curriculum conversations, and potentially make data-driven decisions for degree program changes for quality improvement.

Table 2
Combined Results from the SLO Priority Ranking and Faculty Touch Hours Surveys

		ACCE SLO Ranking		Chico State SLO Ranking Step 1		Faculty Hours Ranking Step 2		Column 4 - 6 Step 3
	Data Column	1	2	3	4	5	6	7
SLO #	Description of SLO	Weighted Average	Priority Ranking	Weighted Average	Priority Ranking	Touch Hours	Touch Hours Rank	Alignment
1	Create written communications appropriate to the construction discipline.	4.57	1	4.49	2	17.6	13	-11
2	Create oral presentations appropriate to the construction discipline.	4.37	9	4.08	5	10.3	19	-14
3	Create a construction project safety plan.	4.39	7	3.51	15	6.5	20	-5
4	Create construction project cost estimates.	4.26	10	4.32	4	66.2	5	-1
5	Create construction project schedules.	4.42	6	4.32	3	42.3	9	-6
6	Analyze professional decisions based on ethical principles.	4.51	2	4.03	7	10.2	17	-10

7	Analyze construction documents for the planning and management of construction processes.	4.49	4	4.51	1	38.3	11	-10
8	Analyze methods, materials, and equipment used to construct projects.	4.49	5	4.08	6	73.5	2	4
9	Apply construction management skills as an effective member of a multi-disciplinary team.	4.50	3	3.84	8	14.3	16	8
10	Apply electronic-based technology to manage the construction process.	4.06	11	3.81	10	64.3	6	4
11	Apply basic surveying techniques for construction layout and control.	3.91	19	2.78	19	18.5	14	5
12	Understand different methods of project delivery and the roles and responsibilities of all constituencies involved in the design and construction process.	4.42	7	3.08	18	11.8	15	3
13	Understand construction risk management.	3.96	14	3.70	13	44.5	8	5
14	Understand construction accounting and cost control.	3.91	17	3.76	12	19.5	12	0
15	Understand construction quality assurance and control.	4.05	12	3.65	14	70.0	4	10
16	Understand construction project control processes.	4.00	13	3.84	9	34.5	10	-1
17	Understand the legal implications of contract, common, and regulatory law to manage a construction project.	3.95	15	3.78	11	31.2	3	8
18	Understand the basic principles of sustainable construction.	3.93	16	2.62	20	7.0	18	2
19	Understand the basic principles of structural behavior.	3.91	18	3.08	17	128.0	1	16
20	Understand the basic principles of mechanical, electrical, and plumbing systems.	3.80	20	3.32	16	48.0	7	9
	Other Curriculum					120.3		
	Total CMGT Curriculum					876.5		

A specific study was previously conducted using the ACCE 20 SLO's to determine if any similarities or differences exist between SLO ranking importance compared to the required SLO taxonomy cognition levels. This study used Stakeholder groupings that included industry practitioners, faculty, and students. One of the study's conclusions revealed there were similar SLO priority rankings within the identified stakeholder groups, yet there was little agreement on the SLO priority ranking between the groups beyond the highest and lowest-ranked SLO's. The difference between groups demonstrates a form of bias in the survey results surrounding the interpretation of the SLO's and ranking their relative importance (Mohammed, Mehany, Gebken, 2020). The results shown in columns 2 and 4 of Table 2 above intimate some similar SLO ranking patterns, indicating similar bias, and validate those findings.

The aforementioned study further concluded that there was no correlation between an SLO's perceived ranking and its expected levels of breadth and depth of SLO-specific knowledge. Equating breadth and depth of cognition level to imply the number of hours instruction hours required for student achievement, another correlation exists between these two studies. The data from this study indicate that the Touch Hours Survey ranking data shown in column 6 of Table 2 do not align with the hierarchy of action verbs used in Bloom's Taxonomy. A logical overview of Bloom's Taxonomies might assume that the more complex the taxonomy, the more curriculum hours are required for students to acquire those skill sets. This assumption is supported by the fact that higher-level taxonomies are comprised of all lower lever taxonomies embedded within the hierarchy framework. However, the results shown in Table 3 from Chico State results do not support this assumption. Of the ACCE's five uses of highest taxonomy "Create", only one made the top five while two made the lowest five in instructional hours. Conversely, of ACCE's nine uses of the lowest used taxonomy "Understand", three made the top five while only one made the bottom five in instructional hours. These results, while derived differently, support the findings that strong correlations may not exist between SLO perceived ranking and the taxonomy level. For this study, the bias created by the Chico State SLO definitions process can not be discounted when considering the potential impact on the data results shown in Table 3. The data results from these two studies are intriguing and provide an opportunity for future research.

Table 3
Comparison of the Ranking between the top and bottom five SLO's based upon the Curriculum Touch Hours Survey in Relationship to Bloom's Taxonomy Verbs

Hierarch of Taxonomy	ACCE SLO Uses of Blooms Verbs	Top 5 SLO Hours	Bottom 5 SLO Hours
Create	5	1	2
Analyze	3	1	1
Apply	3	0	1
Understand	9	3	1
	20	5	5

Actions Taken

Using the results produced from the data collected by this methodology, the educational units' curriculum committee was able to generate a data-driven list of action items to improve the alignment between its Curriculum Touch Hours and the SLO Priority Ranking results. After a year of weekly meetings, Table 4 lists the major curriculum changes that were made to the degree program and have been implemented beginning in Fall 2020.

Table 4
Action Items Based Upon SLO Misalignment

Gap Found		Action Taken
Non-SLO Touch Hours		Reassignment of 104 hours to SLO-specific content.
SLO 1	Written Communication	Reassignment of 3-semester units to add a second "writing proficiency" course outside the CMGT curriculum.
SLO 7	CMGT Core Skills	Addition of a Construction Management Core Skills course.
SLO 18	Sustainability	Reassignment of a Sustainability / Lean / LEED course.
SLO 19	Structural	Reduction in curriculum hours for reassignment.
A revised Introduce-Reinforce-Direct Assessment curriculum map		
A revised list of course prerequisites to assist in student learning and Graduation Initiative 2025, a California State University system-wide requirement		

Conclusions

This methodology attempts to provide a framework for a Degree Program to determine if its current curriculum aligns with how the Educational Unit and its Industry Advisory Council prioritize the Student learning Outcome skill sets. The finding within this paper are limited because it was only applied to a single Construction Management degree program. Limitations also include the Degree Program's specific SLO definitions bias, the IAC member curriculum priority due to local market conditions, geographic region, individual focus on construction sectors, and industry expertise. Other limitations included the Faculty's unique perspectives due to their educational expertise, industry experience, and teaching philosophies. This diversity is validated by comparing the differential SLO priority ranking results shown in columns 2 and 4 in Table 2.

The methodology was successful in demonstrating misalignments between the existing curriculum touch hours dedicated to teaching SLO content versus the prioritized SLO Ranking provided by the educational unit faculty and its local Industry Advisory Council at California State University, Chico. The data input from the local industry helped to bridge the gap between academia and industry (Lee, Jeffreys, Ponton, Choh, 2011) as well as provide an understanding of the construction industry's priorities (McCall, Wetzel, Leathem, Collins, 2019). The resulting data provided the impetus for data-driven and resource-based decisions for degree program improvement (Bugg, 2019), a study of the existing curriculum to confirm what is being taught in the degree program (Koppang, 2004), and production of a revised I-R-DA map (Sadd, 2014). The subsequent creation and implementation of these changes is the intent of learning-based outcome accreditation and fully complies with any accreditation body's mandatory Quality Improvement Plan standards. Lastly, the simplicity of this methodology can be easily applied by other educational units to validate the alignment of degree program curriculum with Student Learning Outcomes.

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