

Opportunities of CM Curriculum Improvement through ABET Student Learning Outcomes

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The results of student learning outcomes demonstrate institutional effectiveness and provide the appropriate and timely feedback to students and faculty for attaining learning and teaching excellence. Systematic assessment of student learning outcomes is undertaken for two purposes. The first is accountability as part of our national approach to quality assurance in higher education. The second application of assessment of learning outcomes is to provide guidance in improving teaching and learning. Accreditation is the primary vehicle for quality assurance in American higher education and the major driver of learning outcomes assessment. Accreditation Board for Engineering and Technology (ABET) is recognized as an accrediting body by the Council on Higher Education Accreditation (CHEA) and joined by Construction Management Association of America (CMAA) in 2015. ABET-CMAA establishes a set of criteria for construction management at the baccalaureate level to accredit Construction Management (CM) programs. Our program, one of the first three ABET accredited CM programs, presents in this article the methodology and procedure of assessing the student learning outcomes at course level and program level. Data has been collected semester by semester for several years, and analysed and discussed at faculty meetings and industry advisor board meetings. These data are used while making decisions in resource allocation, facility improvement, software updates, student clubs, and student competition activities. The learning outcome assessment is a continuous procedure which helps in improving the teaching and learning experience in faculty and students and improving the education quality in construction management. The methodology and procedure can also be references for other construction management programs which will apply for the ABET accreditation.

Keywords: student learning outcome, ABET, assessment, accreditation

Introduction

Student learning outcomes are central to the purpose of educational organizations, and the assessment of these outcomes supplies some of the most important evidence demonstrating institutional effectiveness (Volkwein, 2011). Pervasive assessment is a necessary condition for providing the appropriate and timely feedback to students and faculty required for benchmarking individual student and institutional excellence. (Hersh and Keeling, 2013) Systematic assessment of student learning outcomes has undertaken for three decades and served for two purposes – accountability and improvement (Kuh and Ikenberry, 2009). As part of national approach to quality assurance in higher education, accreditation is the primary vehicle for quality assurance in American higher education and the major driver of learning outcomes assessment. Institutional assessment approaches are examined as part of the process of external review during accreditation (Kuh and Ikenberry, 2009). Assessment approaches should be sufficient to document the skills and competencies expected of students earning associate's, bachelor's, and master's degrees (Ewell, 2013). The second purpose of learning outcomes assessment is to provide guidance in improving teaching and learning. Kuh and Ikenberry (2009) addressed that tools for gathering appropriate evidence need to be

far more fine-tuned than those appropriate in the context of accountability, and must lend themselves to considerable disaggregation to reveal patterns of strengths and weaknesses across different kinds of students and different dimensions of ability. Using assessment to improve teaching and learning can be considerably enhanced if assessment results can be benchmarked against established standards. Such benchmarking not only enables programs to know where they stand, but also allows them to identify potential “best practices” that they can learn from. In fact, one of National Institute of Learning Outcome Assessment’s (NILOA) major interests is to discover what institutions are doing by way of assessment and to share the most promising of these practices across the field. (Ewell, 2013)

The curricular changes in engineering and engineering technology education stimulated by Accreditation Board for Engineering and Technology, Inc.(ABET) are especially instructive, because much of the impetus is originated outside the academy by practitioners via the accreditors. ABET was founded in 1932 as the Engineers Council for Professional Development. Its name was changed in 1980 to the Accreditation Board for Engineering and Technology, and it is now known simply as ABET. ABET is now the pre-eminent organization accrediting undergraduate and graduate education programs in engineering, engineering technology, applied science, and computing. At present, ABET accredits more than 3,300 programs at more than 680 institutions in 24 nations. ABET is recognized as an accrediting body by the Council on Higher Education Accreditation (CHEA). Construction Management Association of America (CMAA) was formed in 1982 as a way to establish a set of standards for managing capital construction projects. In 2013 CMAA was accepted by ABET as the lead society for accreditation of CM (Construction Management) programs. It helps ABET to assure that undergraduate CM education effectively prepares students to enter the profession. ABET-CMAA has approved the first program-specific criteria for construction management at the baccalaureate level in 2015. These criteria are a direct reflection of the needs of the construction management field. Three construction management programs have already achieved ABET accreditation in 2015 with many more schools in the application queue. These programs are at Brigham Young University, Pittsburg State University, and the University of North Florida.

Methodology

Our program prepares for ABET accreditation by following the close loop program assessment procedure (see Figure 1). The assessment is a continuous process of collecting, evaluating, and using information to determine if and how well performance matches learning and teaching expectations. For assessment to be truly effective, it must be authentic, meaningful, reflective and self-regulated. The purpose of assessment is to use the results to inform meaningful dialogue about how instructional and non-instructional activities can be modified to engage students in the learning process and sustain teaching and learning effectiveness.

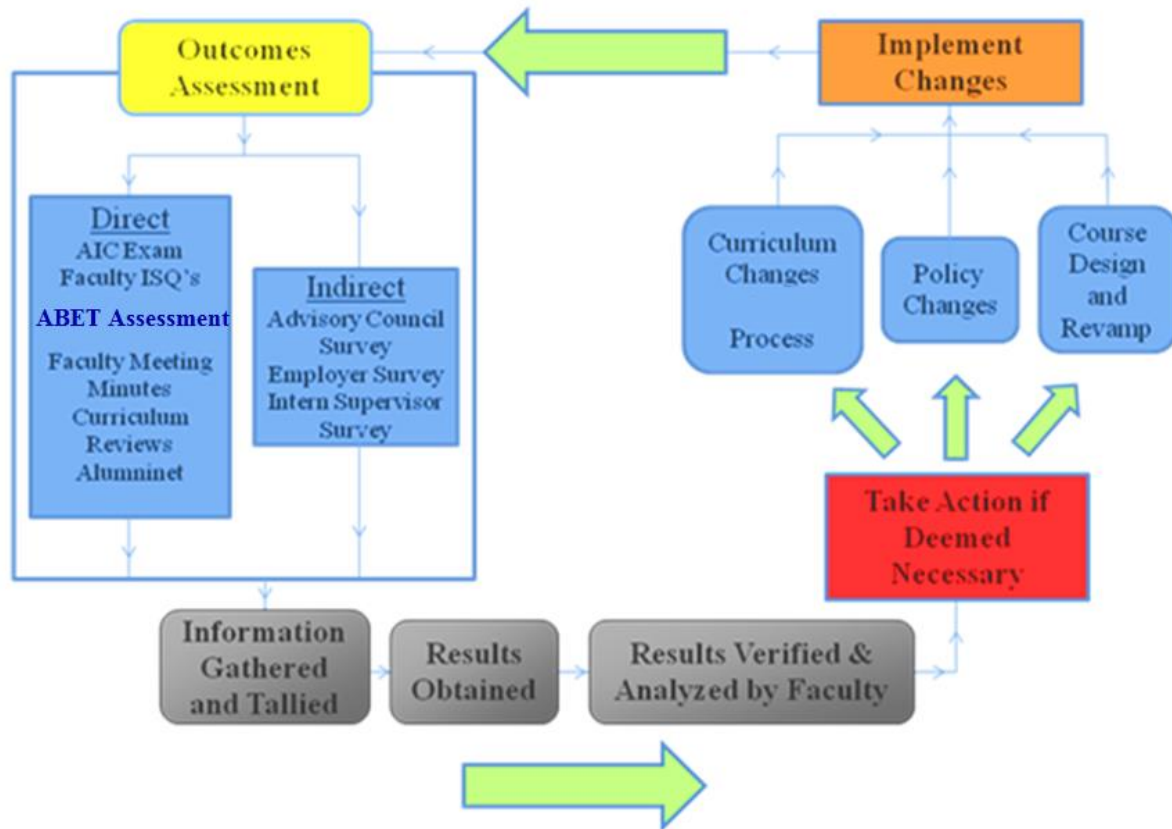


Figure 1 Program Self-assessment Procedure

Among these processes of self-assessment, Outcome Assessment is a data collection procedure which includes the following data collection methods:

1. Senior capstone course: All graduating seniors are required to complete Construction Project Management Capstone course. Students are assigned to several groups. Each group is assigned a real construction project. Students are required to make proposals which include detailed project cost estimate, project schedule, safety plans, site plans, and quality control plans. At the end of the course, the students present their proposals to the faculty and invited industrial professionals who review and evaluate students' work.
2. Internship evaluations: All students are required to take one internship course. Students write biweekly internship journals to the end of the course. The journal should include but not limited to the topics of ethics, quality control, and leadership. At the end of the course, the students' internship supervisors turn in evaluation forms regarding students' performance against the internship course outcome expectations. The professor of the course tallies all the results and submits a report showing the strengths and weaknesses of the students' performance during the internship.
3. Student learning outcome assessment: Student learning outcomes (SLOs) are statements about what students will understand, apply, analyze, and be able to do as a result of an educational experience. The assessment of learning outcomes of our program exists at the course and program levels. The learning outcome assessment starts at the course level, with curriculum mapping demonstrating alignment from the course up through program levels. Construction management core courses are selected to measure students' learning outcomes. The student learning outcomes of each course are discussed and approved at the faculty

meetings. By the end of each semester, Professors make student learning outcome assessment reports for the selected core courses. One report for one course. Each report analyzes the learning outcomes of a course against the ABET assessment criteria 3 a-k (Engineering Accreditation Commission, 2014) by categorizing the students' performance and/or grades into 5 Likert scale (see the Table 1). The Table 1 shows a course outcome assessment Table which is used to calculate the percentage of students falling into each category and the average Likert score of a particular course outcome. These outcomes of a course are reviewed and analyzed by the Faculty and a plan of action for improvement is stated and will be implemented in the following semester.

Table 1

Course outcome assessment table for one of the learning outcomes of a course

Outcome 1 (insert course outcome):						
Relevant ABET a-k (select as many as apply):						
Assessment Instrument (Exam, quiz, assignment etc.; briefly describe assignment, and attach copy of assignment and rubric, if applicable):						
Results: (Complete the table below, and provide as separate files copies of the best and worst student work for this assessment)						
# Students Assessed	# Scoring 5	# Scoring 4	# Scoring 3	# Scoring 2	# Scoring 1	Mean Likert Score
Action Plan to Improve Student Performance:						

Note: Assessment Scale:

5 = 90% -100%

4 = 80% - 89%

3 = 70% - 79%

2 = 60% - 69%

1 = Less than 60%

4. Senior exit surveys: Given at the end of each semester, the graduating seniors fill out a survey questionnaire covering such topics as the curriculum, teaching, student clubs, software, equipment and lab facilities. Analyzing the data allows the department to determine if the program is helping graduates achieve the intended outcomes and accordingly faculty make decisions in program resource planning.
5. Industry surveys and alumni surveys: Industry surveys are distributed each Fall and Spring semester at the Employer Showcase. The survey is given to industry representatives with questions geared towards evaluation of the current construction management (CM) curriculum and student performance. The analysis of this data assists the department in evaluating the success of achieving long term objectives per the ABET criteria 2 (Engineering Accreditation Commission, 2014) for graduates as well as receiving industry input on the current curriculum. Alumni surveys are distributed each Fall and Spring semester at the Employer Showcases and Alumni Socials as well as a yearly distribution to alumni outside of those two events.
6. Advisory board evaluations and faculty evaluations: The Construction Management Advisory Board meets monthly to review and discuss areas such as the department curriculum, student clubs, industry integration, and student learning outcome assessment. The board consists of alumni, industry representatives, and

student representatives. The Faculty also periodically meet with the advisory board to review recommendations.

The data collected through the above assessment methods are used to evaluate student outcomes against the ABET criteria 3 student outcomes and criteria 2 program educational objectives (See Table 2)

Table 2

Assessment Methods/Data Sources Used to Assess Program Outcomes and Educational Objectives

	Student Outcomes											Program Educational Objectives				
Data Collection Methods	a	b	c	d	e	F	g	h	i	j	k	1	2	3	4	5
Capstone Senior Project	√	√	√	√	√	√	√			√	√		√			
Student Outcome Assessment	√	√	√	√	√	√	√	√	√	√	√					
Industry Survey												√	√	√	√	√
Alumni Survey												√	√	√	√	√
Senior Exit Survey	√	√	√	√	√	√	√	√	√	√	√	√				
Internship Evaluations	√	√	√	√	√	√	√			√	√					
Advisory Board Evaluations	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
Faculty Evaluations	√	√	√	√	√	√	√	√	√	√	√					

Note: refer a-k to ABET criteria 3 student outcomes, and 1-5 to ABET criteria 2 program educational objectives.

The close loop program assessment procedure goes through several steps (see Figure 1) and needs to engage current construction management students, alumni, industry professionals, department faculty, and program administration and staff in each step. Since the assessment is a continuous process of collecting, evaluating, and applying information to improve performance to match learning and teaching expectations, timing and frequency of data collection of each assessment method is key and is scheduled as shown in Table 3.

Table 3

Constituency and Timing of Data Collection

Constituency	Data Collection Method	Timing of Data Collection
Current Construction Management Students	Capstone Senior Project	Every Fall and Spring Semester
	Senior Exit Survey	Every Graduating Senior
	Feedback from Student Representatives on Advisory Board	Monthly Meetings
Alumni of the program	Alumni Survey	Every Fall and Spring Semester
	Advisory Board Member Participation	Monthly Meetings
	Alumni Evaluations of Student Internships	Every Semester
Industry professionals	Employer Survey	Every Fall and Spring Semester
	Advisory Board Member Participation	Monthly Meetings
	Internship Evaluations	Every Semester
Departmental Faculty	Faculty Meetings – discussion of collective student achievements and Likert scores for every class.	One meeting dedicated to data review, evaluation and assessment each Spring and Fall

Our program utilizes an application program, Tracdat, for reporting and tracking academic program student learning outcomes and its continuous improvement. The CM program learning outcomes and associated periodic course student learning outcome assessment are posted to Tracdat. The application displays how well the program is performing on meetings its objectives on measured student learning outcomes as well as the program educational objectives. A sample Tracdat screen shot is shown below in Figure 2.

BCN4944 :Construction Management Intern

Course Outcomes	Measures	Results and Evaluation	Actions & Follow-Up
people skills - Work with all types of people.	Directly related to Course Outcome	Reporting Period: 2015 Result Type: Desired Result Met There are 18 students assessed. 12 out of 18 students are scored 5/5, 4 out of 18 are 4/5, 2 out of 18 are 3. The average score is 4.55. (06/07/2016) Was this result obtained in a CBTL course?: Yes Related Documents: 2016 Spring - BCN 4944 - Construction Management Internship - Malek.pdf 2016 Spring Industry Evaluation of Intern.pdf	Action Taken: 1. The desired result is met. 2. Encourage students to be members of student clubs, engage in the community services, etc. 3. Improve the class average to 5.00 (06/07/2016)
	Field Placement Supervisor Rating - Intern Supervisor's evaluation form Desired Result: The class average is expected to be 3.50 (satisfactory or above).	Reporting Period: 2015 Result Type: Desired Result Met The average score of the class is 4.82 (07/23/2015) Related Documents: CM Intern Syllabus-2015-spring-ABET.docx Internship outcome assessment-2015 Spring -ABET.docx	Action Taken: Improve the class average to 5.00 (07/23/2015) Action Taken: Encourage students to be members of student clubs, engage in the community services, etc (07/23/2015)
		Reporting Period: 2014 Result Type: Desired Result Met The class average is 4.83. (03/16/2015) Related Documents: CM Intern Syllabus-2014-spring.docx Supervisor Evaluation.pdf Internship outcome assessment-2014 Spring.docx	Action Taken: 1. Encourage students to be members of student clubs. 2. Improve the class average to 5.00 (03/16/2015)
logical think - Think and reason logically.	Directly related to Course Outcome	Reporting Period: 2015 Result Type: Desired Result Met There are 18 students assessed. 14 out of 18 students are scored 5/5, 3 out of 18 are scored 4/5, and 1 out of 18 are scored 3/5. The average is 4.72/5. (06/07/2016) Was this result obtained in a CBTL course?: Yes Related Documents: 2016 Spring - BCN 4944 - Construction Management Internship - Malek.pdf 2016 Spring Industry Evaluation of Intern.pdf	Action Taken: 1. The desired result is met 2. More training in critical thinking courses. 3. Improve the class average to 4.8 (06/07/2016)
	Field Placement Supervisor Rating - Intern Supervisor's evaluation form Desired Result: The class average is	Reporting Period: 2015 Result Type: Desired Result Met The average score of the class is 4.64. (07/23/2015)	Action Taken: More training in critical thinking courses. (07/23/2015)

Figure 2. Screen shot of a sample Tracdat

Data Analysis and Discussion

Senior capstone course is designed for the senior CM students to experience, with the contractor's perspective, all stages of a construction project which covers from project selection to project close-out. It requires students to apply cumulative knowledge and skills gained from the CM program to make project cost estimate, project schedule, construction site plan, safety plan, and quality control plan. Members of the construction companies are invited to participate with the instructor in defining the project scope and grading the proposals and project presentations of student teams. The course is offered per the student enrollment. We have been following up on the student outcome assessment starting from 2015 spring and collect data of three semesters. There are two or three student teams each semester who are given different actual commercial projects. All proposal packages from student teams are required to be acceptable. The instructor's goal is to have one exceptional project, one midpoint project, and one project that is still adequate, but not necessarily as good as the other two. The instructor's goal has been achieved through these semesters. Industrial professionals recognize that our students are ready to enter into the construction industry.

However, the skills in quantity takeoff, project scheduling by software, and presentation need to be improved. The instructor take actions to improve student skills in these areas and student performance maintains above 4.0 out of 5.0 through the three semesters. The instructor informs colleagues at the faculty meeting of the areas which need to be improved. The related courses such as construction cost estimating, project scheduling and planning, and introduction to construction computing are adjusted to help in achieving higher student outcome expectation.

The Construction Management Internship Course is a course designed to make students apply knowledge and skills learned from the CM program and learn more hands-on skills from industry. It also prepares students to enter the industry. Some students get full-time job offers after the internships. There are nine course outcomes to measure students' intern performance by interns' supervisors. We collect outcome assessment data starting from 2013 summer through 2016 summer (see Figure 3). The horizontal axis displays the nine course outcomes in Figure 3. The average score of each outcome is above 4.25 out of 5.0. The highest outcome scores 4.72 and 4.68 out of 5.0 fall into two outcomes – “Be computer literate and internet capable” and “work with all types of people”. The lowest outcomes scores 4.25 and 4.26 are “understand and solve construction problems” and “to make sound economic decisions”. The weaknesses of intern students are addressed at the faculty meeting and all construction management core courses are expected to incorporate project oriented instruction method and hands-on project components.

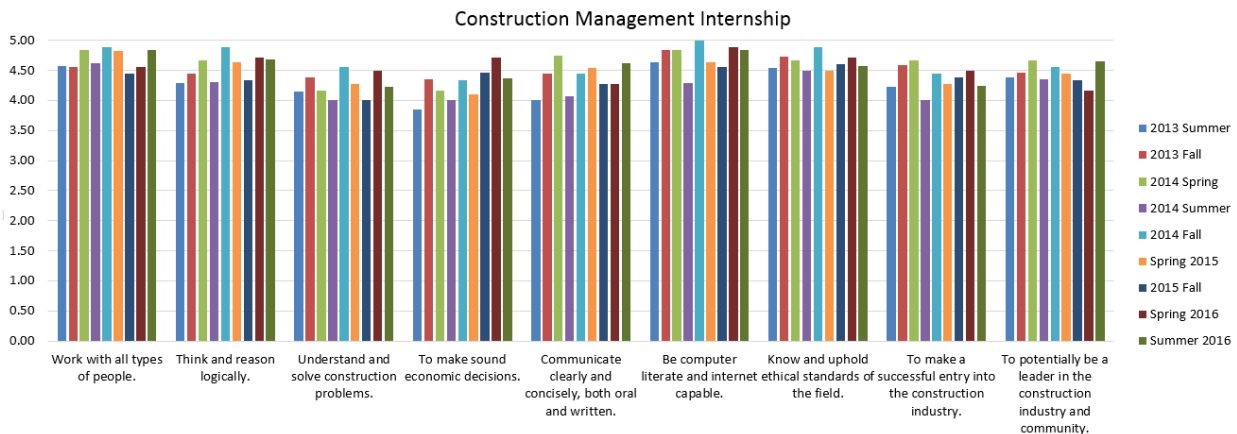


Figure 3 Student learning outcome assessment of Construction Management Internship

Student learning outcome assessment is conducted at the course level. Faculty set up the learning outcomes/objectives and map these outcomes/objectives to ABET a-k criteria for each CM course. Due to the limitation of the article size, we pick one course, Construction Materials, to explain the assessment procedure and results. The course has three learning outcomes/objectives (see Figure 4). The student learning outcome is collected from two semesters. The instructor expected student learning outcome is to be 3.5 or above with respect to each learning objective. The instructor teaching in 2015 Fall conveys the weakness of students to the instructor teaching the same course in 2016 Spring. The student learning outcome has been improved in the following semester. Regarding the second learning outcome, the student performance is not as good as the previous semester, but still meets the instructor's expectation. Instructors who teach the same course communicate with each other through the assessment of each learning outcome to improve teaching and learning effectiveness.

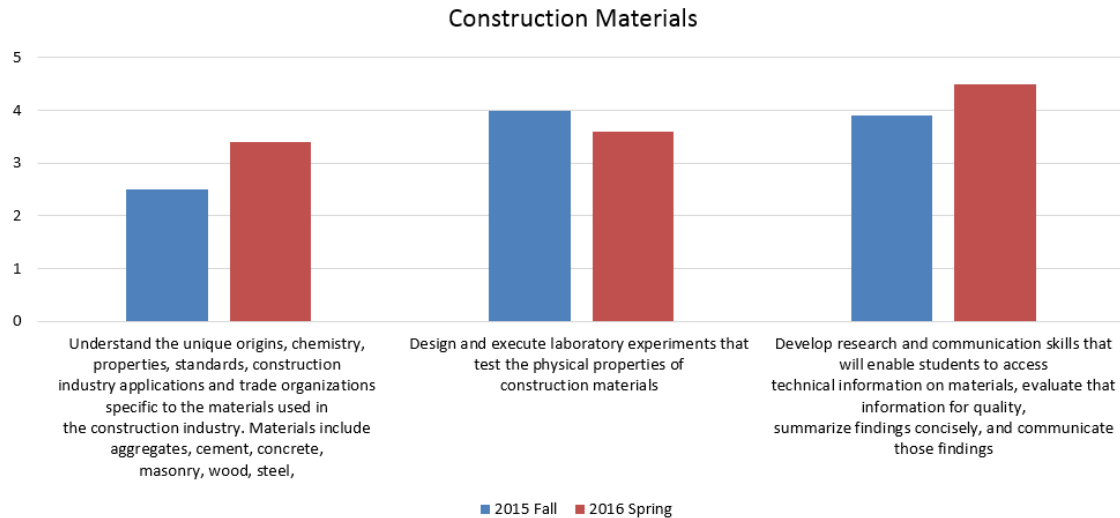


Figure 4 Student learning outcome assessment of Construction Materials

The Senior Exit Survey is conducted in the last semester before students graduate from the program. It covers most aspects about the program, from initiating the master program to facility and curriculum improvement. Data has been collected since 2013 Fall. One of the strategic plans of our CM program is to initiate a master degree program. The surveys from 2013 Fall to 2016 Spring continuously show that more than 40% of graduates plan on continuing to a Master's degree. And the demands to pursue a Master's degree in construction keep growing since 2013 Fall. This demand urges the administration to start a proposal of establishing a Master's degree in 2017 Fall.

The CM program has one advisor who is in charge of advising students, registering transfer students, and other enrollment issues. Surveys show that students are satisfied with the advising but request more office hours from the advisor. After adjusting and increasing the office hours, the advising gets higher recognition and appreciation.

Regarding the facilities which include the computer labs and software, construction material and electrical and mechanical labs, classrooms and library, students comment on better computers and popular estimating, scheduling, and drafting software. Our program engages the information technology team of the college to provide more upgraded computers in the lab and open the labs for longer periods. The information technology team also contacts related software companies to obtain licenses of estimating, scheduling, and drafting and Building Information Modeling software. Students also ask for improving the construction materials, mechanical and electrical labs. The department head coordinated with the college dean and the coordinator of the civil engineering department. With their support, the CM department received funds and additional lab rooms to purchase equipment, devices, and materials to improve the lab facility.

The Senior Exit Survey also asks graduates about student support programs which includes student clubs and corresponding competitions, such as Association of Builders and Contractors (ABC), National Association of Home Builders (NAHB), Design Build Institute of America (DBIA), employment showcase, and hard hat banquet for graduates. Data has been collected since 2013 Fall and it shows that the employment showcase and hard hat banquet are highly recognized by graduates. The employment showcase is held twice a year – Fall semester and Spring semester - and the hard hat banquet is held in the spring semester for graduates. These events help students obtain internships, part-time jobs, and even full-time jobs and establish industry networks. The student clubs are also well recognized in student networking. Students of the clubs participate in competitions of commercial building, residential building, and design-build project delivery. Due to the great performances in the nationwide residential building competition, our CM program obtained funds from NAHB and local contractors to establish a residential

construction track which fits in the local construction industry well. However, students comment on early advisement of the clubs so the students can get earlier assistance and advice in acclimating to the program and campus life.

The interesting part of the survey asks students to self-evaluate their abilities, which are also listed in the internship supervisor's evaluation form. We have collected data since 2013 and average the data against the expected construction management abilities to enter the industry. The Figure 5 shows the comparison of supervisors' evaluation versus student self-evaluation. The internship supervisors' gave higher or quite the same evaluation as students' self-evaluation.

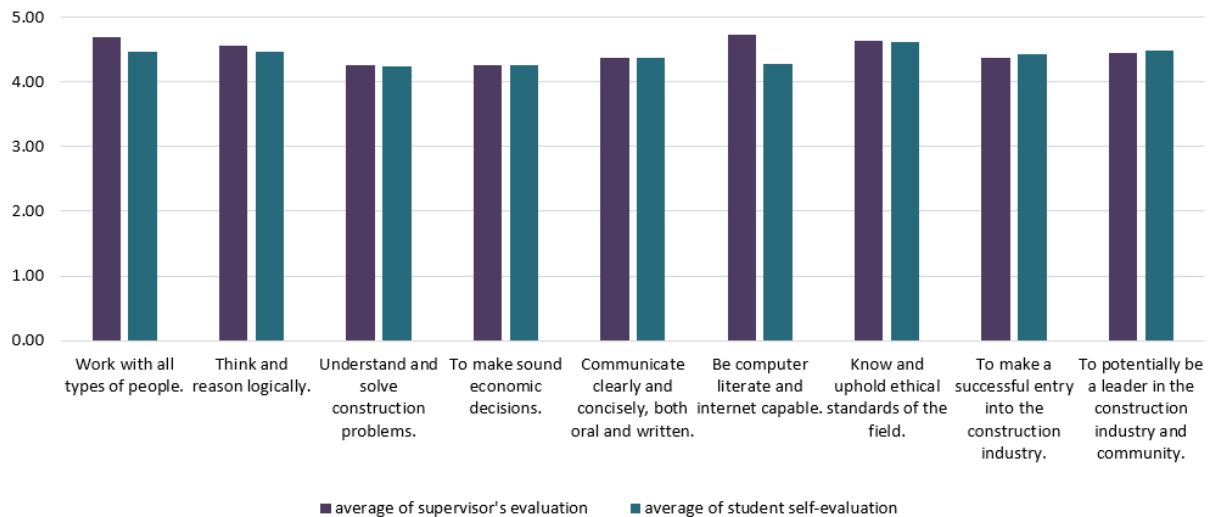


Figure 5 Supervisors' evaluation versus student self-evaluation regarding the expected construction management abilities

Conclusion

As part of our national approach to quality assurance in higher education, institutional accrediting organizations all require institutions to undertake assessment. Driven by accreditation organization ABET-CMAA and program self-improvement motivation, a systematic close-loop assessment of learning outcomes methodology is devised by our CM program, which is one of the first three institutions accredited by ABET-CMAA. The methodology engages faculty, industry professionals, alumni, and current program students. Multi data collection procedures are undertaken, such as ABET student learning outcome report at course level per semester, internship supervisors' evaluation, senior exit surveys, and alumni surveys. Collected data covers most of the concerns and further development and improvement of the CM program, such as advising, facility, curriculum, Master's programs, teaching and learning effectiveness, etc. The fine-tuned data are analyzed at faculty meetings and industrial advisory board meetings and continuous improvement suggestions are noted. These analyses and suggestions are guidelines for administration at university, college, and departmental levels are conducted to make decisions in resource allocation and inform and communicate to program constituents the program performance. The assessment results are benchmarked against the standards established by ABET-CMAA. Such benchmarking not only enables programs to know where we stand, but also allows us to identify potential "best practices" to improve the program and serve the construction industry needs.

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