Civil Engineering Assessment Plan

NOTE: The assessment plan and results are depicted in the Criterion 3 and Criterion 4 sections of this program's self-study for accreditation under ABET, Inc. These sections are on the following pages

CRITERION 3. STUDENT OUTCOMES

A. *Student Outcomes*

Student Outcomes

Student Outcomes for the SD MINES Civil Engineering program are as follows:

Students must demonstrate…

a. an ability to apply knowledge of mathematics, science, and engineering
b. an ability to design and conduct experiments, as well as to analyze and interpret data
c. an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
d. an ability to function on multidisciplinary teams
e. an ability to identify, formulate, and solve engineering problems
f. an understanding of professional and ethical responsibility
g. an ability to communicate effectively
h. the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
i. a recognition of the need for, and an ability to engage in life-long learning
j. a knowledge of contemporary issues
k. an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

These outcomes, which are the same as the ABET Student Outcomes (a)-(k), were adopted by the faculty and supported by the CE Department Professional Advisory Board (PAB).

The Student Outcomes are available for the general public through the departmental website: http://www.SD Mines.edu/Academics/Departments/Civil-and-Environmental-Engineering/Civil-and-Environmental-Engineering/ and in the university course catalog (http://ecatalog.SD Mines.edu/).

B. *Relationship of Student Outcomes to Program Educational Objectives*

Student Outcomes prepare students to achieve the Program Educational Objectives (PEOs). Although all of the student outcomes are essential in helping students meet the PEOs, some student outcomes are more closely related to specific PEOs. Table 3-1 shows the mapping between Student Outcomes and PEOs. From the table it is seen that all of the Student Outcomes are essential in preparing students to "engage in the professional practice of civil and environmental engineering." The second and third PEOs, "actively participate in professional and/or civic organizations" and

"pursue opportunities to assume leadership roles in their professional and/or service activities," are related to participation and leadership within the profession. Student Outcomes (d) and (f)-(j) engage students in working in teams, developing communication skills, and developing a global perspective of engineering and professionalism which will prepare them to participate in professional and civic organizations and to be leaders in these organizations. The final PEO "Seek to continue their educations through advanced studies in civil or environmental engineering or a related professional discipline, continuing education and/or professional development activities" is directly addressed through Student Outcomes (f) and (h)-(k). These outcomes emphasize the need for lifelong learning and the importance of understanding ever changing global and contemporary issues and modern engineering tools as well as the professional/ethical responsibility of staying current with engineering practices.

Table 3-1. Student Outcomes Mapped to Program Educational Objectives

		Program Educational Objectives			
		1. Engage in the professional practice of civil and environmental engineering,	2. Actively participate in professional and/or civic organizations	3. Pursue opportunities to assume leadership roles in their professional and/or service activities,	4. Seek to continue their educations through advanced studies in civil or environmental engineering or a related professional discipline, continuing education and/or professional development activities.
Student Outcomes	a. an ability to apply knowledge of mathematics, science, and engineering	•			
	b. an ability to design and conduct experiments, as well as to analyze and interpret data	•			
	c. an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability	•			
	d. an ability to function on multidisciplinary teams	•	•	•	
	e. an ability to identify, formulate, and solve engineering problems	•			
	f. an understanding of professional and ethical responsibility	•	•	•	•
	g. an ability to communicate effectively	•	•	•	
	h. the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context	•	•	•	•
	i. a recognition of the need for, and an ability to engage in life-long learning	•	•	•	•
	j. a knowledge of contemporary issues	•	•	•	•
	k. an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.	•			•

CRITERION 4. CONTINUOUS IMPROVEMENT

This section provides a detailed report of our assessment and evaluation process, and how it is used for continuous improvement of our program.

Section A describes the assessment processes used to gather the data upon which the evaluation of each student outcome is based, the frequency with which these assessment processes are carried out, the expected level of attainment for each of the student outcomes, summaries of the results of the evaluation process, an analysis illustrating the extent to which each of the student outcomes is being attained, and how the results are documented and maintained.

Section B describes how the results of the evaluation processes for the student outcomes and any other available information have been systematically used as input in the continuous improvement of the program, the results of any changes (whether or not effective) in those cases where re-assessment of the results has been completed, and any significant future program improvement plans based upon recent evaluations.

A. Student Outcomes

Since our last ABET accreditation visit in 2010 two different assessment approaches have been used to measure and evaluate student outcomes a-k:

- Current Assessment Plan (2011-12, 2014-15, and 2015-16)
- Intermediate Assessment Plan (2012-13 and 2013-14)

To distinguish between the two different assessment plans, all references to the intermediate assessment plan, including results, are shown in **red**. References and results pertaining to the "Current Assessment Plan" are left in black font and characters.

The term "Intermediate Assessment Plan" refers to the fact that we switched for two years 2012-13 and 2013-14 to an approach to assessment that emphasized summative assessments in the senior year.

The term "Current Assessment Plan" refers to the fact that we followed an assessment process that was more distributed through the curriculum during 2011-12 and then returned to this process during the last two years (2014-16) of the current review cycle. We continue to follow this assessment process and, therefore, characterize it as "current."

Current Assessment Plan (2011-12, 2014-15, and 2015-16)

Following the 2010 ABET reaccreditation site visit, we initiated a major revision of the assessment and continuous improvement plan based on information gained at the 2010 ABET Sustainable Assessment Workshop (Rogers, 2010). In January 2011, faculty developed assessment rubrics with performance indicators to be used in a course-based assessment plan for the Student Outcomes (a) – (k). During the 2011 – 2012 academic year, faculty measured

performance in required junior-level courses, the senior design sequence of courses (CEE 464/465 at that time) and the professional practice class (CEE 463). In addition to courses, FE topics related to specific student outcomes were included in the assessment process

In January of 2013 an intermediate assessment plan was implemented based on information received at an ABET Assessment workshop (see description of the intermediate plan below). In September of 2014, based on the recommendations of a consultant, we reinstated the assessment plan originally developed in 2011 (referred to in this document as the Current Assessment Plan). The assessment plan is based on the performance indicators and evaluation rubrics developed by the faculty in 2011 and utilizes courses across the curriculum for assessment as well as FE exam results.

Intermediate Assessment Plan (2012-13 and 2013-14)

In January 2013, the previous assessment coordinator (Scott Amos) attended the ABET Institute for the Development of Excellence in Assessment Leadership (IDEAL) (Kranov and Warnock, 2013) which led to a significant change to the plan regarding assessment analysis and evaluation of Student Outcomes (a) – (k). The primary measures of this summative assessment plan were designed to assess student attainment of ABET Student Outcomes (a) – (k) as achieved by students completing the BSCE curriculum. This summative approach focused on direct measures using assignments in the capstone design course (CEE 489), the professional practice course (CEE 463), and FE exam results.

The current plan provides assessments across the curriculum as opposed to a limited number of senior-level courses (CEE 489 and CEE 463) and is much more engaging of the faculty. In the following sections the current assessment process is described followed by the assessment results and continuous improvements implemented through both the current and intermediate assessment plans.

1. Assessment Process

The current assessment process is summarized in Table 4-1. From the table it is seen that assessment data contributing to the evaluation of student outcomes is collected biannually (end of fall and spring semesters) and evaluated annually at the end of spring semester. Measurements based on specific instruments (exam questions, reports, projects etc.) are made in selected courses related to each student outcome as well as FE exam results. Mapping of candidate courses for assessment and FE exam topics to student outcomes is given in Table 4-2. Two to three courses related to each outcome are selected for assessment. A schedule of the courses which were used for assessment for both the current and intermediate assessment plans is given in Table 4-3 with a summary of the types of instruments utilized in relationship to each outcome being given in Table 4-4. The instruments used to assess each course were evaluated using common rubrics developed by the faculty. The current assessment plan rubrics for student outcomes are given in the corresponding results section of outcomes a-k. Table 4-5 maps each student outcome to the corresponding assessment rubric.

The intermediate assessment plan utilized Engineering Design Rubrics (EDRs) and Engineering Professional Skills Assessment (EPSA) rubrics for assessments. These rubrics are mapped to student outcomes in Table 4-6 with the EDRs being given in Table 4-7 through Table 4-14 and the EPSA rubrics being given in Table 4-15 through Table 4-19.

2. Frequency
As shown in Table 4-1 Student Outcomes a-k as well as FE exam assessment data are collected biannually (each semester) by the instructors of courses being used for assessments, or (in the case of the FE Exam) by the coordinator of the results. The data are summarized annually following spring semester and provided to all department faculty for review and discussion at the annual department ABET assessment meeting. The results of the meeting as well as the assessment summary are documented by the coordinator. Individual course assessments are documented by course instructors in ABET Student Outcome a-k binders. Every six years the ABET assessment plan will be reviewed to update the process and levels of attainment as needed.

3. Level of Attainment
Attainment goals for ABET Student Outcomes a-k as well as FE exam pass rates are given as follows:

- Student Outcomes a-k: 80% of students to meet or exceed expectations (3 or above using rubrics or 75% for numerically scored items).

- FE Exam: At or above the national average pass rate for all CE topics.

Table 4-1. CE Assessment Process

Process	Description	Frequency	Personnel
1. Data Collection	• Collect outcome a-k assessment results for selected courses (see Table 4-2). Document in ABET course binders including outcome assessment summary sheet, copies of instruments used including student work for each instrument, and number of students meeting or exceeding expectations. • Collect FE exam results (see Table 4-2). • Document in corresponding ABET course binders how each FE topic is being addressed and level of student performance. • Individual course assessments and actions for improvement to be documented in ABET course binders.	biannual biannual biannual annual	Instructors Coordinator Instructors All Faculty
2. Summarize Data	• Summarize assessment data for outcomes a-k and FE results and disseminate to faculty for review prior to annual department ABET assessment meeting.	annual	Coordinator
3. Department Evaluation	• Review effectiveness of previous improvement action plans (reassessment). • Review current assessment results and identify critical areas for improvement. Develop action plans for addressing deficiencies. These may be course or program level actions.	annual	All Faculty
4. Document Results	• Document effectiveness of previous improvement actions (reassessment). • Document student performance related to each ABET outcome and FE exam topic. • Document new course and program improvement actions for future reassessment.	annual	Coordinator
5. Assessment Plan Review	• Review/update performance indicators. • Review/update levels of attainment. • Review/update assessment process.	Every 6 years	All Faculty

Table 4-2. Assessment Data Sources

	Assessment Sources	
Outcome	**Candidate Courses for Assessment Data** (Req'd courses **bold**)	**CE FE Exam Results**
(a). An ability to apply knowledge of mathematics, science, and engineering.	EM **214**, **321**, **331** CEE **316**, **326**, 327, **336**, 337, **346**, 347, 353	Mathematics Statics Dynamics Mechanics of Materials Materials Fluid Mechanics Structural Analysis
(b). An ability to design and conduct experiments, as well as to analyze and interpret data.	CEE **284**, **316L**, 327L, **336L**, **346L**	Probability and Statistics
(c). An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.	CEE **325**, **336**, 425, 426, 427, 447, 448, 451, 453, 456, 457, 468, **489**	NA
(d). An ability to function on multi-disciplinary teams	CEE **316**, **325**, 425, 456, **474**, **489**	NA
(e). An ability to identify, formulate, and solve engineering problems	EM **321**, **331** CEE **316**, 325, **326**, **336**, **346**, 353, 425, 426, 427, 447, 448, 451, 453, 456, 457, 468, **489**	Hydraulics/Hydrologic Systems Structural Design Geotechnical Engineering Transportation Engineering Environmental Engineering
(f). An understanding of professional and ethical responsibility	CEE **130**, **325**, 327, 425, 456, **463**, **474**, **489**	Ethics and Business Practices Construction
(g). An ability to communicate effectively	CEE **316**, **325**, 327, **336**, **346**, 425, 437, 456, **463**, **474**, **489**	NA
(h). The broad education necessary to understand the impact of engineering solutions in a global and sustainable (economic, environmental, and societal) context	CEE **316**, **325**, **326**, 327, 337, 425, 426, 427, 433, 456, **463**, **474**, **489**	Engineering Economics
(i). A recognition of the need for, and an ability to engage in life-long learning	CEE **130**, **325**, 425, **463**, **474**, **489**	NA
(j). A knowledge of contemporary issues	CEE **316**, **325**, **326**, 327, **336**, 425, 428, 437, 463, **474**, **489**	NA
(k). An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.	CEE **117**, **206**, **284**, **316**, **325**, **336**, 337, 353, 421, 426, 427, 433, 437, 447, 448, 451, 453, 456, 457, 468, **474**, 475, **489**	Computational Tools Surveying

Table 4-3. Student Outcome Data Collection Schedule

Outcome	2011-2012	2012-2013*	2013-2014*	2014-2015	2015-2016
a	CEE 353	CEE 464/465	CEE 489	EM 331	EM 331
	CEE 331			EM 321	EM 321
b	CEE 316L	CEE 464/465	CEE 489	CEE 316L	CEE 316L
	CEE 346L			CEE 346L	CEE 346L
				CEE 327L	CEE 327L
c	CEE 336	CEE 464/465	CEE 489	CEE 325	CEE 325
				CEE 489	CEE 489
d		CEE 464/465	CEE 489	CEE 325	CEE 325
		CEE 463	CEE 463	CEE 489	CEE 489
e	CEE 353	CEE 464/465	CEE 489	CEE 426	CEE 426
	CEE 346			CEE 456	CEE 456
f	CEE 463	CEE 465	CEE 489	CEE 463	CEE 463
	CEE 474	CEE 463	CEE 463	CEE 474	CEE 474
g		CEE 465	CEE 489	CEE 463	CEE 463
		CEE 463	CEE 463	CEE 489	CEE 489
h	CEE 325	CEE 464/465	CEE 489	CEE 325	CEE 325
	CEE 464	CEE 463	CEE 463	CEE 326	CEE 326
i	CEE 325	CEE 465	CEE 489	CEE 463	CEE 463
	CEE 463	CEE 463	CEE 463	CEE 474	CEE 474
j	CEE 326	CEE 464/465	CEE 489	CEE 326	CEE 326
		CEE 463	CEE 463	CEE 474	CEE 474
k	CEE 336	CEE 464/465	CEE 489	CEE 433	CEE 336
				CEE 457	CEE 457

*Intermediate assessment plan (2012-13 and 2013-14). Assessments were limited to Capstone Design (CEE 464/465 and CEE 489) and Professions (CEE 463).

Table 4-4. Student Outcome Assessment Instruments

Assessment Instruments	Student Outcome										
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)
Select Exam Questions	x				x						x
Project/Homework		x	x		x			x			
Reports		x	x				x				
CATME Surveys				x							
Case Study Discussions						x	x	x		x	
Essays						x			x	x	
Student Surveys						x			x		
FE Exam Topic Specific Results	x	x			x	x		x			x

Table 4-5. Current Assessment Plan Student Outcome Assessment Rubrics

Assessment Rubrics	Student Outcome										
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)
Rubric (a) (Table 4-26)	x										
Rubric (b) (Table 4-31)		x									
Rubric (c) (Table 4-35)			x								
Rubric (d) (Table 4-39)				x							
Rubric (e) (Table 4-44)					x						
Rubric (f) (Table 4-49)						x					
Rubric (g) (Table 4-53)							x				
Rubric (h) (Table 4-58)								x			
Rubric (i) (Table 4-62)									x		
Rubric (j) (Table 4-66)										x	
Rubric (k) (Table 4-71)											x

Table 4-6. Intermediate Assessment Plan Student Outcome Assessment Rubrics

Assessment Rubrics	Student Outcome										
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)
EDR 1 (Table 4-7)					x					x	
EDR 2 (Table 4-8)	x		x	x					x		x
EDR 3 (Table 4-9)		x	x			x		x	x	x	
EDR 4 (Table 4-10)		x	x	x				x			x
EDR 5 (Table 4-11)	x	x	x		x						x
EDR 6 (Table 4-12)						x			x	x	
EDR 7a (Table 4-13)							x				
EDR 7b (Table 4-14)							x				
EPSA 1 (Table 4-15)						x					
EPSA 2 (Table 4-16)				x			x				
EPSA 3 (Table 4-17)								x			
EPSA 4 (Table 4-18)									x		
EPSA 5 (Table 4-19)										x	

Table 4-7 Engineering Design Rubric 1: Problem Clarification

EDR 1	Problem Clarification: *Clearly articulates the problem after a thorough exploration of client and stakeholder raw data. Fully maps these data to the design aspects of the project. Clearly presents target technical specifications, design methods and alternatives to be considered and completed.*					
	0 - Missing	1 - Emerging	2 - Developing	3 - Competent	4 - Maturing	5 - Mastering
Stakeholder Perspective	Stakeholder perspectives beyond the client are missing.	Few, if any, stakeholder perspectives beyond the client are taken into consideration during problem clarification.		The perspectives of most stakeholders have been considered, but only at a given point during problem clarification.		The needs of the client and the perspectives of all stakeholders have been carefully weighed throughout problem clarification.
Problem Clarification	Problem clarification is missing.	Problem clarification is cursory and non-methodical. The team does not consider raw data from the client or from stakeholders. There are no target technical specifications.		Client raw data (but not stakeholder raw data) are referenced and the problem is clarified, but some of the steps during the problem clarification process have been skipped or treated superficially. There are a meager number of target technical specifications that consist of metrics and values.		The problem is reviewed and reformulated using a systematic approach that includes proper treatment of client and stakeholder raw data, needs and target technical specifications. All necessary target technical specifications consist of accurate and complete metrics and values.
Technical Information	Technical information is missing.	Little or no evidence that related technical information was taken into consideration.		The problem is adequately articulated but teams may have not fully considered related technical information.		The problem is clearly articulated with well-defined parameters that realistically consider related technical information

Table 4-8 Engineering Design Rubric 2: Design Development-Concept Generation

EDR 2	**Design Development – Concept Generation:** *Uses multiple strategies, approaches, and materials, to generate a variety of ideas and alternatives to systematically explore possible solution paths.*				
	0 - Missing	**1 - Emerging**	**2 - Developing**	**3 - Competent**	**4 - Maturing**	**5 - Mastering**
Search Strategies	Search strategies are missing.	Little or no evidence that specific strategies have been used to generate concepts. External searches are frequently not current, relevant, and/or accurate. Little or no attention paid to source evaluation.		Evidence that multiple search strategies were used to generate concepts, but the approach may not have been systematic. External searches are mostly current, relevant, and accurate. The team has not interviewed lead users or experts working in the discipline.		Search strategies, including both internal and external searches, are used to systematically generate and explore concepts. External searches are current, relevant, and accurate. Sources exhibit breadth and depth. The team has interviewed lead users and consulted closely with experts.
Design Development	Evidence of design development is missing.	Little or no evidence of Design Development.		The team conducts a shallow design development process.		The team develops the problem into a set of sub functions; a set of subsystems; a sequence of actions; and/or the set of primary client preferences.
Concept Generation	Evidence of organization in the concept exploration process is missing.	Little or no evidence of organization in the concept generation process.		The team struggles to organize the generation process in a way that best guides the creative energies and technical interests of the team.		Strong evidence that the generation process has been skillfully managed in ways that organize and guide the creative energies and technical interests of the team.

Table 4-9 Engineering Design Rubric 3: Impact Analysis

EDR 3	**Impact Analysis:** *Considers the relevant impacts of the design in ethical, global, economic, societal, cultural, and environmental contexts. Clearly shows how relevant considerations have influenced target technical specifications and alternatives that were identified in the proposal.*				
0 - Missing	**1 - Emerging**	**2 - Developing**	**3 - Competent**	**4 - Maturing**	**5 - Mastering**
Evidence that an Impact Analysis was completed is missing.	Little or no evidence that Impact Analysis was used to consider the potential impacts of the design on multiple contexts: ethical, global, economic, societal/cultural and environmental.		Some evidence that Impact Analysis techniques were used to consider *some but not all* of the *appropriate* potential impacts of the design on multiple contexts: ethical, global, economic, societal/cultural and environmental.		Clear evidence is shown that Impact Analysis was performed to analyze the likely impacts of the design on multiple contexts: ethical, global, economic, societal/cultural and environmental.
Evidence that the team's Impact Analysis has influenced target technical specifications is missing.	Little or no evidence is shown that the team's Impact Analysis has influenced (augmented or modified) target technical specifications that were identified in the Proposal.		Some evidence is shown that the team's Impact Analysis has influenced (augmented or modified) target technical specifications that were identified in the Proposal		Clear and ample evidence is shown that the team's Impact Analysis has influenced (augmented or modified) target technical specifications that were identified in the proposal

Table 4-10 Engineering Design Rubric 4: Design Development-Concept Selection

EDR 4	**Design Development – Concept Selection:** *Methodically narrows down design choices in ways that refine concepts and lead to focusing on the most promising design solutions* that incorporate relevant considerations identified in the Impact Analysis.				
0 - Missing	**1 - Emerging**	**2 - Developing**	**3 - Competent**	**4 - Maturing**	**5 - Mastering**
Systematic approach to concept selection is missing	Little or no evidence of a systematic approach to concept selection.		A concept selection process is evident but some of the steps may have been skipped or completed in an erroneous and/or superficial manner.		A thorough and systematic process of concept selection is evident, on that includes decision matrixes, concept screening and scoring and consensus building.
Explanation of why the design concept was selected is missing.	The team does not explain why the design concept was selected.		The team adequately articulates the merits of the selected design concept, but not the rationale of selection over other concepts.		The team clearly articulates the merits of the selected design concept and the rationale for selection.

Table 4-11 Engineering Design Rubric 5: Engineering Analysis and Design

EDR 5	**Engineering Analysis and Design:** *Skillfully synthesizes the results of modeling, simulation, and prototyping to refine the design and/or reformulate the problem.*				
0 - Missing	**1 - Emerging**	**2 - Developing**	**3 - Competent**	**4 - Maturing**	**5 - Mastering**
Analysis and modeling are missing.	Analysis and modeling are poorly handled and quantitative tools have frequently been misapplied.		Analysis and modeling have been adequately handled but quantitative tools may sometimes have been applied incorrectly.		Analysis and modeling have been skillfully handled and demonstrate the appropriate application of quantitative tools.
Calculations are missing.	Calculations are frequently inaccurate and/or unorganized. Little evidence that the underlying mathematical concepts have been grasped.		Calculations are mostly accurate, but may display some misunderstanding about underlying assumptions and mathematical concepts.		Calculations are complete, accurate, self-generated and show a deep understanding of the assumptions and mathematical concepts.
Design is missing for the target methodology.	Design is inadequate for the target methodology.		Design is adequate, but does not go beyond routine methods for problem clarification or problem reformulation.		Careful analysis leads to insightful problem clarification or problem reformulation.

Table 4-12 Engineering Design Rubric 6: Final Design Results and Recommendations

EDR 6	**Final Design Results and Recommendations:** *Presents clear and concise results of the analysis and design. Insightful recommendations for future design work that identify lessons learned, limits, and constraints of the current project.*				
	0 - Missing	**1 - Emerging**	**2 - Developing**	**3 - Competent**	**4 - Maturing**	**5 - Mastering**
Recommendations	Recommendations for future work are not made.	Any recommendations for future work seem to have little or no connection with the results of the current work.		Recommendations are mostly reasonable and balanced, but may not have fully considered the limits and constraints of the current project.		Recommendations are based on analysis that are reasonable and balanced and that consider the limits and constraints of the current project.
Life-Long Learning Skills	Life-long learning skills are missing.	The team demonstrates few if any life-long learning skills, approaching the problem passively, without ideas about how to obtain needed information.		The team identifies still existing knowledge gaps, but may demonstrate difficulty in figuring out how to address those gaps.		The team demonstrates life-long learning skills by identifying knowledge gaps and by suggesting methods for addressing those gaps.
Design Results	Design results are missing.	Design results and ideas about how future work might proceed are lacking and/or are very impractical.		Design results and ideas about how future work might proceed are included in the recommendations.		Design results along with innovative yet practical ideas about how future design work could proceed are included in the recommendations.

Table 4-13 Engineering Design Rubric 7a: Written Communication

EDR 7a	**Written Communication:** *Communicates in an organized and professional manner with multiple audiences, including clients, stakeholders, other team members and professional reviewers.*				
	Written Documents				
	0 - Missing	**1 - Emerging**	**2 - Developing**	**3 - Competent**	**4 - Maturing**	**5 - Mastering**
Design Process	The written document does not capture or communicate the design process.	The written document inadequately captures and communicates the design process and product/s for identified audiences. Little attention is paid to accuracy		The written document captures and communicates the design process and product/s accurately and clearly for identified audiences.		The written document captures and communicates the design process and product/s accurately and clearly for both direct and indirect audiences.
Visual Clarity	Visuals are missing.	Visuals (charts, tables, Gantt charts, diagrams, schematics and photos, etc.) are frequently inappropriate, difficult to decipher and may even detract from written communication.		Visuals (charts, tables, Gantt charts, diagrams, schematics and photos, etc.) generally support the written component, but some may be overly complex/simplistic or unclear due to improper resolution.		Visuals (charts, tables, Gantt charts, diagrams, schematics and photos, etc.) are clear, concise and have been chosen for their ability to support and extend the written component.
Errors		Frequent errors obscure and/or misrepresent the content.		Errors exist, but do not distract from or misrepresent the content.		Writing is polished, professional, and virtually error free.

Table 4-14 Engineering Design Rubric 7b: Oral Communication

EDR 7b	**Oral Communication:** *Communicates in an organized and professional manner with multiple audiences, including clients, stakeholders, other team members and professional reviewers.*				
	Oral/Visual/Multimedia Presentations				
	0 - Missing	**1 - Emerging**	**2 - Developing**	**3 - Competent**	**4 - Maturing**	**5 - Mastering**
Logic	Presentation's logic is missing.	Gaps and digressions make it somewhat difficult for the audience to follow the presentation's logic.		Presentation's logic is generally easy to follow with only few minor gaps and digressions.		Presentation has a narrative logic that the audience can easily follow and presenters have compellingly conveyed why the issue matters.
Illustration	Illustrations are missing.	The narrative is not generally supported by illustrations or it is not fully clear how the chosen support items add credibility to the topic. Presenters do not seem engaged.		Illustrations and anecdotes generally support the narrative. There may be a few areas where a supporting visual or some background information is still needed. Some presenters seem more engaged than others.		The narrative is supported by illustrations that lend credibility to the story. The presenters' engagement is evident.
Clarity	Main point is non-existent.	Not always easy to identify main points and transitions may be rough. Visuals may be off-target or difficult to decipher. Too much off-topic information not directly applicable to the main point.		Generally easy to identify main points and transitions are usually smooth. Visuals may be overly complex, simplistic or unclear and does not directly contribute to the main point.		Main takeaways are "sticky" (they "stick" with the audience) and are smoothly tied together. Visuals are clear, concise, and have been chosen for their ability to support and extend the verbal component.

Table 4-15 Engineering Professional Skills Assessment Rubric 1

EPSA 1							
		Problem Identification: Students clearly frame the problem(s) raised in the scenario and begin the process of resolution. **Stakeholder Perspective:** Students recognize relevant stakeholders and their perspectives. **Ethical Considerations:** Students identify related ethical considerations (e.g. health and safety, fair use of funds, risk, schedule and "doing what is right" for all involved).					
		0 – Missing	**1 – Emerging**	**2 – Developing**	**3 – Competent**	**4 – Maturing**	**5 – Mastering**
1.1	**Problem Identification**	Students do not identify the problem(s) in the scenario.	Students begin to frame the problem, but have difficulty separating primary and secondary problems. If approaches to address the problem are advocated, they are quite general and may be naïve.		Students are generally successful in distinguishing primary and secondary problems. There is evidence that they have begun to formulate credible approaches to address the problems.		Students convincingly frame the problem and parse it into sub-problems. They suggest detailed and viable approaches to resolve the problems.
1.2	**Stakeholder Perspective**	Students do not identify stakeholders.	Students identify few stakeholders, vaguely stating their positions or misrepresenting their positions.		Students consider perspectives of major stakeholders and convey these with reasonable accuracy.		Students thoughtfully consider perspective of all relevant stakeholders and articulate these with great clarity, accuracy and empathy.
1.3	**Ethical Considerations**	Students do not give any attention to ethical considerations.	Students give passing attention to related ethical considerations.		Students are sensitive to some relevant ethical considerations and discuss them in context of the problem(s).		Students clearly articulate relevant ethical considerations and address these in discussing approaches to resolve the problem(s).

Table 4-16 Engineering Professional Skills Assessment Rubric 2

EPSA 2							
		Group Interaction: Students work together to address the problems raised in the scenario by acknowledging and building on each other's ideas to come to consensus. **Group Self-Regulation:** Students invite and encourage participation of all discussion participants.					
		0 – Missing	**1 – Emerging**	**2 – Developing**	**3 – Competent**	**4 – Maturing**	**5 – Mastering**
2.1	**Group Interaction**	Students do not interact as a group.	Students pose individual opinions, without considering other student's ideas.		Students try to balance everyone's input and build on/clarify each other's ideas.		Students clearly encourage participation from all group members, generate ideas together and actively help each other clarify ideas.
2.2	**Group Self-Regulation**	There is no evidence of group self-regulation.	Some students monopolize or become argumentative. There may be some tentative, but ineffective, attempts at reaching consensus.		Students attempt to reach consensus, but have some difficulty in developing ways that equitably consider multiple perspectives.		Students clearly work together to reach a consensus in order to clearly frame the problem and develop appropriate, concrete ways to resolve the problem.

Table 4-17 Engineering Professional Skills Assessment Rubric 3

EPSA 3							
		Impact/context: Students consider how their ways to address the problem impact relevant global, economic, environmental, and cultural/societal contexts. **Global:** Students relate the issue or proposed approaches to larger global issues (such as globalization, world politics, etc.) **Economic:** Students relate the issue or proposed approaches to trade and business concerns (such as project costs). **Environmental:** Students relate the issue or proposed approaches to local, national or global environmental issues (such as ozone depletion). **Cultural/Societal:** Students relate the issue or proposed approaches to the needs of local, national, or ethnic groups affected by the issue.					
		0 – Missing	**1 – Emerging**	**2 – Developing**	**3 – Competent**	**4 – Maturing**	**5 – Mastering**
3.1	**Impact/context**	Students do not consider the impacts of the solutions.	Students give cursory consideration to how the ways to address the problem impact in relevant contexts.		Students give evidence on how the ways to address the problem impact in relevant contexts.		Students clearly examine and weigh the impact of the ways to address the problem in all relevant contexts.

Table 4-18 Engineering Professional Skills Assessment Rubric 4

EPSA 4			**Knowledge Status:** Students consider what needs to be learned (what they know and don't know). **Discerning Fact from Opinion;** Students distinguish fact from opinion in the scenario. **Sources/References:** Students verbalize a credible plan to retrieve and organize needed data. **Presumptions:** Students take action to respond to personal beliefs that might hinder attainment of a satisfactory solution.				
		0 – Missing	**1 – Emerging**	**2 – Developing**	**3 – Competent**	**4 – Maturing**	**5 – Mastering**
4.1	**Sources/ References**	Students do not question sources or references.	Students begin to question sources/references cited in the scenario.		Students question sources/references cited in the scenario.		Students evaluate sources/references cited in the scenario.
4.2	**Discern Fact/Opinion**	Students do not distinguish between facts and opinions expressed in the scenario.	Students begin to distinguish between fact and opinion expressed in the scenario.		Students demonstrate some ability to distinguish between fact and opinion expressed in the scenario.		Students are successful in distinguishing fact from opinion expressed in the scenario.
4.3	**Knowledge Status**	Students do not differentiate between what they do and do not know.	Students begin to identify what they know as well as what they do not know, but have difficulty differentiating between the two.		Students identify what they know, as well as what they don't know.		Students identify what they still need to know and describe methods for obtaining that information.
4.4	**Presumptions**	Students do not recognize their own presumptions that may hinder their problem solving.	Students begin to recognize their own presumptions, but have difficulty recognizing how these presumptions may hinder their problem solving.		Students recognize their own presumptions that may hinder their problem solving.		Students take action to address their own presumptions that may hinder their problem solving.

Table 4-19 Engineering Professional Skills Assessment Rubric 5

EPSA 5			**Non-Technical Issues:** Students consider non-technical issues such as societal, economic and political concerns in their discussion, identification of the problem(s), and possible ways to address the problem(s). **Technical Issues:** Students also display awareness of relevant technical issues/methods/tools surrounding the problem(s).				
		0 – Missing	**1 – Emerging**	**2 – Developing**	**3 – Competent**	**4 – Maturing**	**5 – Mastering**
5.1	**Non-Technical Issues**	Students do not consider any current societal, economic, and/or political issues.	Students give only a superficial consideration to current societal, economic, and/or political issues. Non-technical issues may be treated in a condescending manner.		Students give some consideration to current societal, economic, and/or political issues.		Students give full consideration to current societal, economic, and/or political issues.
5.2	**Technical Issues**	Students do not consider modern methods, technologies and/or tools.	Students give only passing consideration to modern methods, technologies and/or tools.		Students give some consideration to modern methods/ technologies and/or tools.		Students give full consideration to modern methods, technologies and/or tools.

4. Summary of Results and Continuous Improvement

This section presents a summary of the assessment results for student outcomes a-k and the FE exam results, followed by individual assessment results and continuous improvement activates for each outcome. A summary of the results of the evaluation process for student outcomes measured in courses as well as FE exam results are provided in Table 4-20 and Table 4-21 respectively.

From Table 4-20 it is observed that the first year the Intermediate Assessment Plan was implemented the department goals were not achieved for any of the student outcomes. As will be shown in the individual outcome assessments, this was primarily due to a lack of communicating expectations to students in CEE 489 and CEE 463. As a result in the following year (2013-14), the EDR and EPSA rubrics were provided to the students with clear explanations of expectations for student performance. As a result it is seen that the percentage of students meeting or exceeding expectation increased dramatically. The results for 2014-15 (current assessment plan) showed students meeting expectations for 6 of the 11 student outcomes. The following year (2015-16) students met expectations for 9 of the 11 student outcomes. From the table it is observed that of the 11 student outcomes students consistently struggle with outcome (a). As a result this outcome has been the primary focus for continuous improvement.

Table 4-20. Percentage of students meeting or exceeding expectations for Student Outcomes (a) – (k) for 2011-2016.

Student Outcome	2011-2012	2012 – 2013*	2013 – 2014*	2014 – 2015	2015 – 2016
(a)	68%	61%	94%	61%	72%
(b)	86%	63%	74%	98%	91%
(c)	55%	61%	80%	78%	89%
(d)	---	67%	86%	86%	95%
(e)	67%	69%	94%	81%	81%
(f)	64%	35%	76%	76%	95%
(g)	---	77%	92%	100%	92%
(h)	100%	37%	67%	68%	95%
(i)	---	35%	78%	70%	88%
(j)	93%	43%	83%	82%	88%
(k)	86%	66%	87%	89%	65%
Scale					
80%-100% meet or exceed expectations		70%-80% meet or exceed expectations	60%-70% meet or exceed expectations	Less than 60% meet or exceed expectations	

*Intermediate assessment plan results

FE exam results for each CE topic along with corresponding student outcome and course(s) is given in Table 4-21. The scores in the table represent SD Mines CE program scores normalized by the national average. Thus a value of 1.0 or higher indicates SD Mines students exceeded the national average while a value less than 1.0 indicates they are below the national average. Note that the values in the last column include only the fall results. The spring 2016 results with be available in July 2016.

From the table it is seen that the overall pass rate for the FE exam has improved over the last three years (2013-2016) in comparison to the previous three years (2010-2012). It should be noted that number of students who sat for the exam over these periods of time is significantly different. 2013 marks the beginning of the computer-based FE exam requiring our students to travel to Casper, WY or Sioux Falls, SD to sit for the exam. As a result we saw a decrease in the number of students taking the exam. Beginning in 2014 a testing center was established on the SD Mines campus resulting in an increase of the number of students taking the exam. Although we are encouraged by the improved pass rate in recent years, we are cautious in interpreting these results as it is likely the most motivated students are making the effort to take the exam and are therefore better prepared than the less motivated students who do not take the exam.

The number of students taking the exam during the 2014-15 academic year increased as a result of having a testing center on campus. A plot of the number of students taking the exam each semester is given in Figure 4-1 with the normalized pass rate being shown in Figure 4-2. We expect to see a continued increase in the number taking the exam providing more reliable assessment results. While students have been above or near the national average for many of the FE topics they have shown the poorest performance overall in the areas of Probability and Statistics as well as Dynamics. As will be seen in the individual outcome results and continuous improvements this resulted in a curriculum change requiring students to take ME 211 (Dynamics) and Math 381 (Intro to Probability and Statistics).

Table 4-21. FE Exam Results 2010-2016

Academic Year			10/11	11/12	12/13	13/14	14/15	F15*
# SD MINES CE examinees			31	30	34	16	21	8
Overall pass Rate			0.73	0.81	0.66	1.02	0.88	0.94
FE Topic	**Outcome**	**Courses**	**10/11**	**11/12**	**12/13**	**13/14**	**14/15**	**F15**
Mathematics	(a)	MATH	0.93	1.00	0.86	1.04	0.93	0.97
Probability and Statistics	(b)	MATH 381 CEE 284	0.85	0.80	0.86	0.94	0.85	1.13
Computational Tools	(k)	CEE 284	0.94	0.99	0.97	0.91	0.90	1.10
Ethics and Professional Practice	(f)	CEE 463	1.03	1.01	1.01	1.07	0.98	1.07
Engineering Economics	(h)	IENG 302	0.94	0.93	0.96	1.17	0.97	0.95
Statics	(a)	EM 214	0.86	1.00	0.89	0.97	0.94	1.06
Dynamics	(a)	ME 211	0.81	0.86	0.78	0.82	1.03	0.74
Mechanics of Materials	(a)	EM 321	0.97	1.02	0.92	0.98	1.03	0.94
Materials	(a)	CEE 316	0.94	1.11	0.93	1.26	0.97	0.99
Fluid Mechanics	(a)	EM 331	0.95	0.93	0.98	1.10	1.05	0.98
Hydraulics and Hydrologic Systems	(e)	CEE 336/337	0.97	0.97	0.86	1.01	1.09	1.09
Structural Analysis	(a)	CEE 353	0.97	0.87	0.88	0.98	1.06	1.07
Structural Design	(e)	CEE 453/456	0.90	1.08	0.94	1.02	1.00	1.13
Geotechnical Engineering	(e)	CEE 346/347 447/448	0.93	1.00	0.95	0.98	0.98	1.12
Transportation Engineering	(e)	CEE 468	0.95	0.97	0.85	1.04	0.94	1.02
Environmental Engineering	(e)	CEE 326/327	0.92	0.91	0.87	1.11	1.00	1.19
Construction	(h)	CEE 474	0.98	1.06	1.05	1.07	0.97	0.98
Surveying	(k)	CEE 206	0.96	0.97	1.06	1.09	1.09	1.01

Scale

Greater than 1.0	0.9 to 1.0	0.8 to 0.9	Less than 0.8

*Fall data only. Spring 2016 data is typically made available in July.

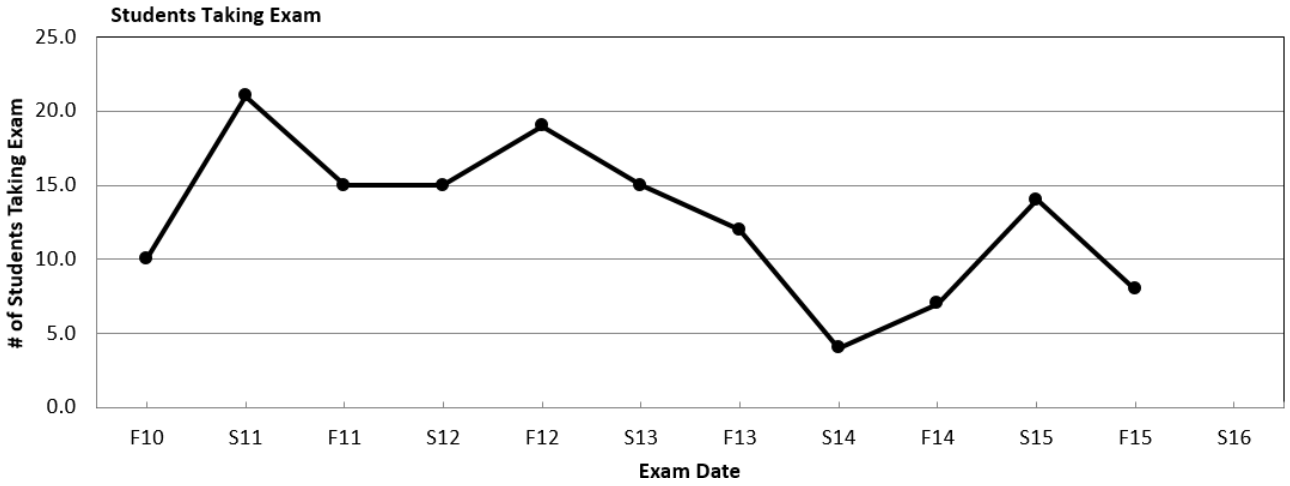


Figure 4-1. Plot of the number of students taking the CE FE exam each semester from 2010 to 2015.

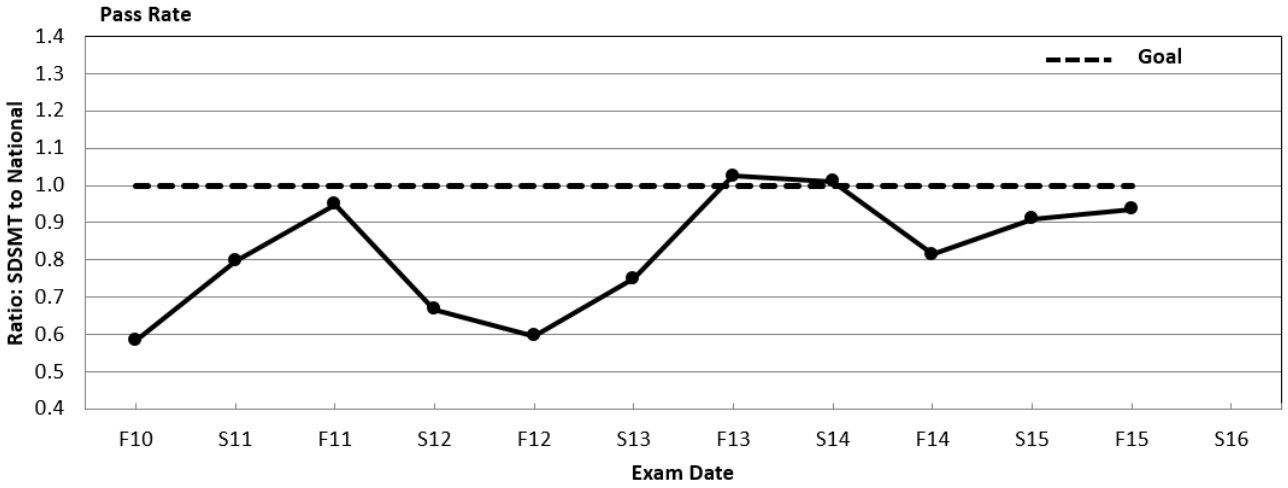


Figure 4-2. Plot of the SD MINES pass rate normalized by the national pass rate for CE students for each semester from 2010 to 2015.

The following sections present the assessment results for each student outcome as well as a summary of the observations and recommended actions by the faculty from the annual ABET assessment meetings. Each section is organized by presenting the summative results from course assessments and related FE results where applicable followed by more detailed results for each of the assessment plans.

Outcome A

An ability to apply knowledge of mathematics, science, and engineering

A summary of the percentage of students meeting or exceeding expectations over the review period (2011-2016) is given in Table 4-22 followed by a summary of the FE exam results related to outcome (a) in Table 4-23 with plotted results for each FE topic provided in Figure 4-4-3**.** Subsequent sections present the assessment results from the intermediate assessment and the current assessment plans along with assessment results/observations and action plans for continuous improvement.

Table 4-22. Outcome (a) Summary 2011-2016

Student Outcome	2011-2012	2012 – 2013*	2013 – 2014*	2014 – 2015	2015 – 2016
(a)	68%	61%	94%	61%	72%
Scale					
	80%-100% of students meet or exceed expectations				
	70%-80% of students meet or exceed expectations				
	60%-70% of students meet or exceed expectations				
	Less than 60% of students meet or exceed expectations				

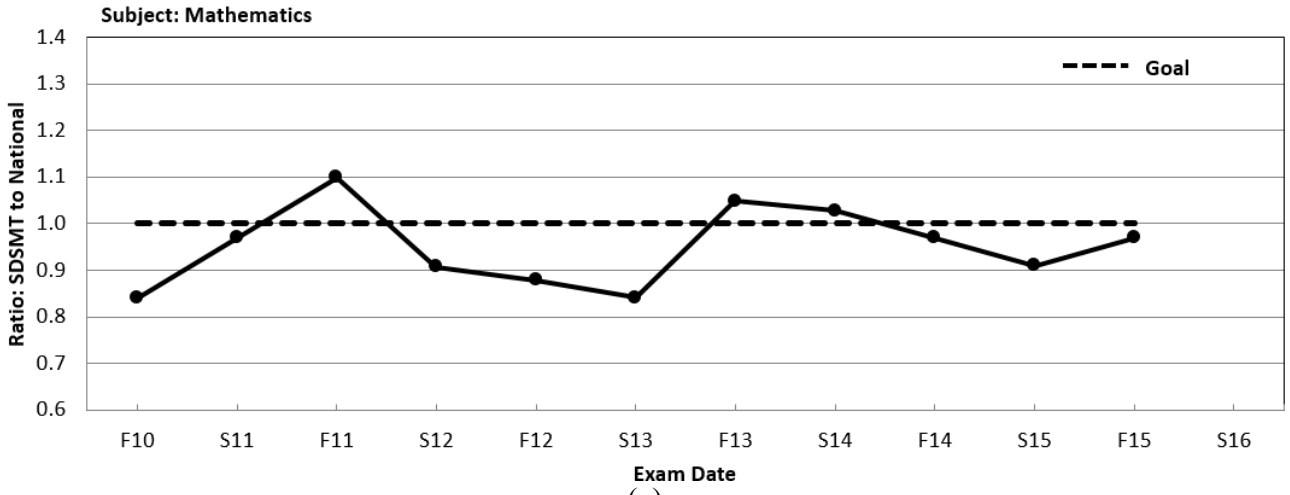
*Intermediate assessment plan results.

FE Results

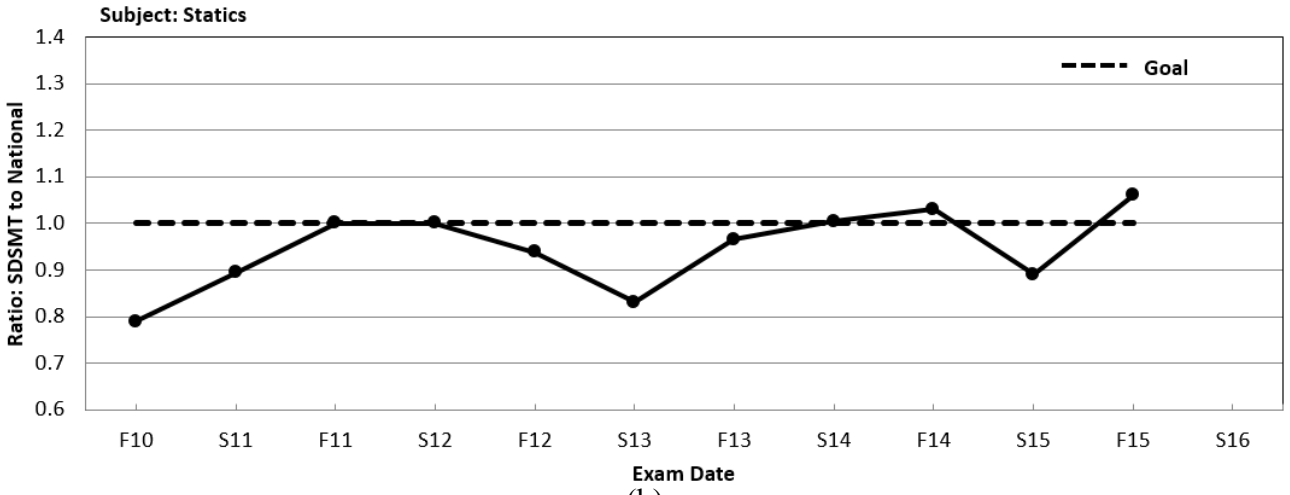
Table 4-23. FE Topics related to Outcome (a) 2010-2016

FE Topic	Outcome	Courses	10/11	11/12	12/13	13/14	14/15	F15
Mathematics	(a)	MATH	0.93	1.00	0.86	1.04	0.93	0.97
Statics	(a)	EM 214	0.86	1.00	0.89	0.97	0.94	1.06
Dynamics	(a)	ME 211	0.81	0.86	0.78	0.82	1.03	0.74
Mechanics of Materials	(a)	EM 321	0.97	1.02	0.92	0.98	1.03	0.94
Materials	(a)	CEE 316	0.94	1.11	0.93	1.26	0.97	0.99
Fluid Mechanics	(a)	EM 331	0.95	0.93	0.98	1.10	1.05	0.98
Structural Analysis	(a)	CEE 353	0.97	0.87	0.88	0.98	1.06	1.07
Scale								
	Greater than 1.0							
	0.9 to 1.0							
	0.8 to 0.9							
	Less than 0.8							

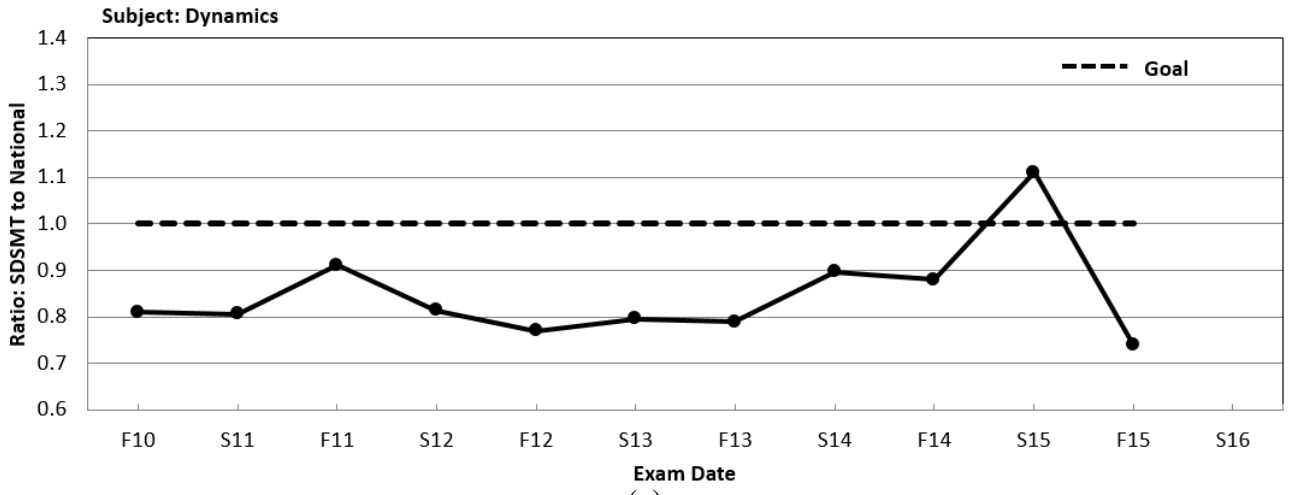
Outcome A



(a)

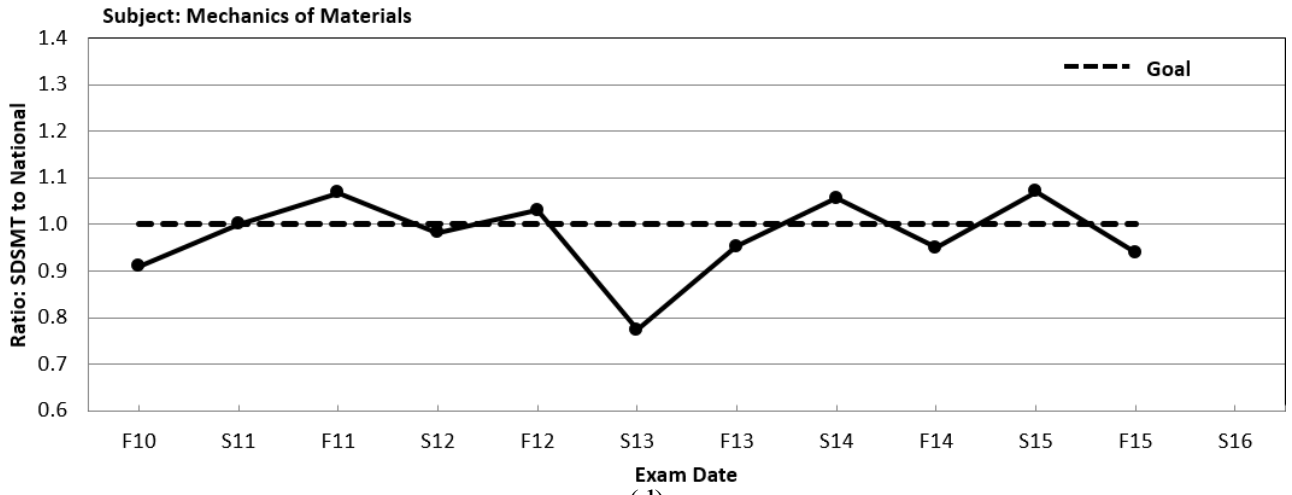


(b)

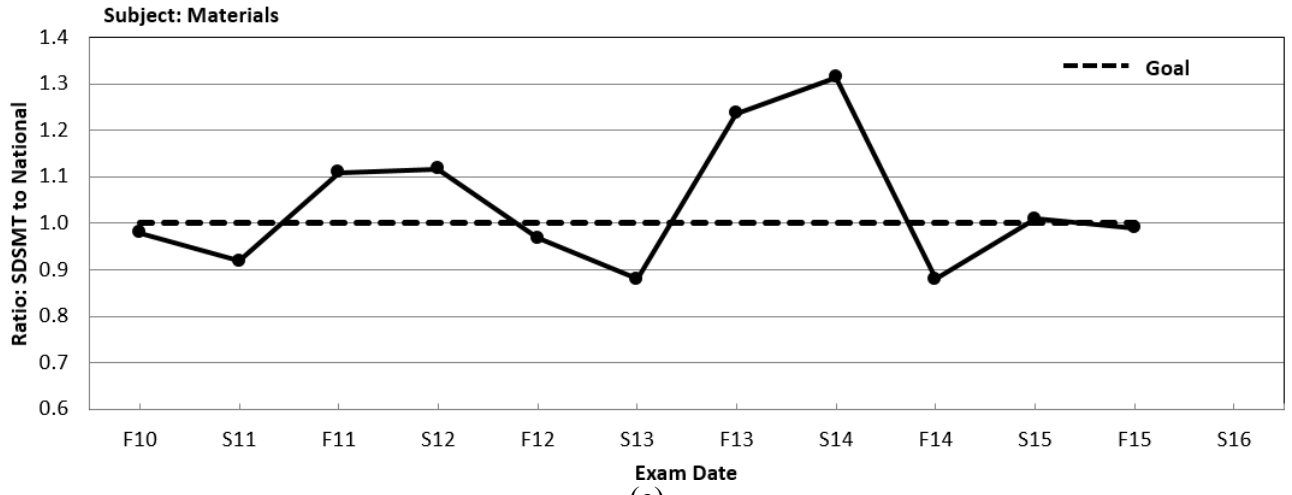


(c)

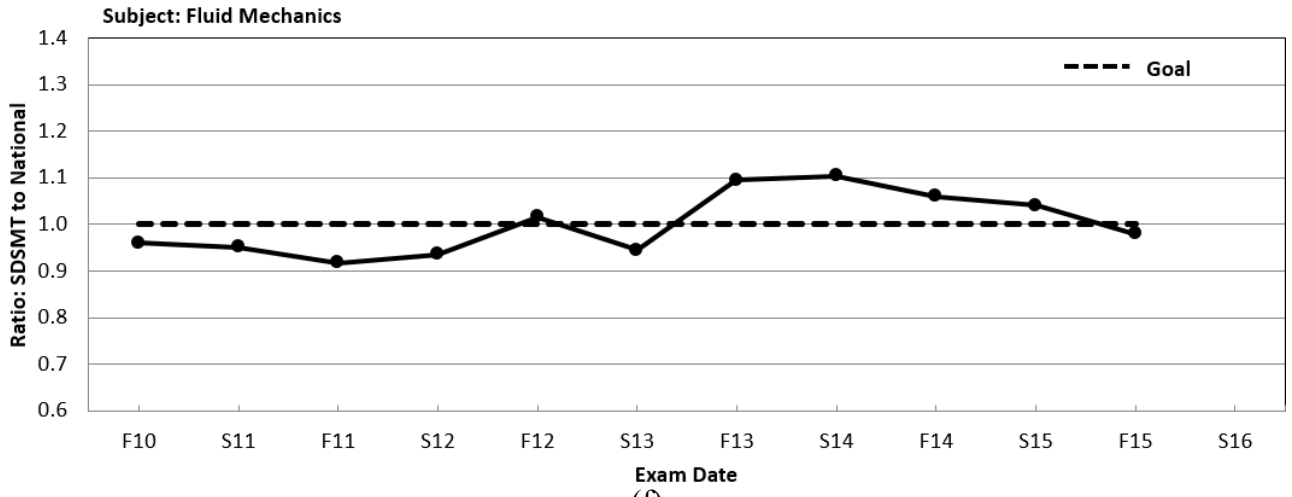
Outcome A



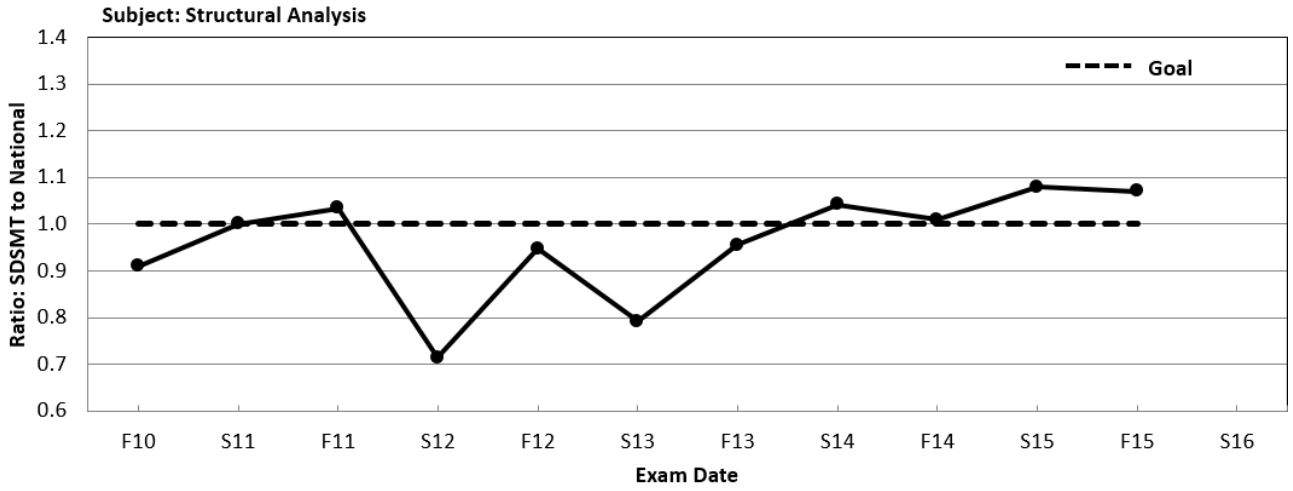
(d)



(e)



(f)



(g)

Figure 4-4-3. Plots of FE results for each semester from 2010-2016 for subjects (a) Mathematics, (b) Statics, (c) Dynamics, (d) Mechanics of Materials, (e) Materials, (f) Fluid Mechanics, and (g) Structural Analysis.

Outcome A

Intermediate Assessment Plan (2012-2014)

This section presents the results from the Intermediate Assessment plan (2012-2014). Data sources related to each performance indicator along with assessment instruments are provided in Table 4-24. A bar graph showing the percentage of students who met or exceeded expectations for each of the performance indicators is shown in Figure 4-4. A summary of the annual assessment results/observations as well as action items for continuous improvement are provided.

Table 4-24. Outcome A: Data Sources 2012-12 and 2013-14

Performance Indicators	Rubric	Source: Instrument
1. Design development/concept generation	EDR 2	CEE 464: Project proposal
2. Engineering analysis and design	EDR 5	CEE 465: Progress Report #2 & #3, final report

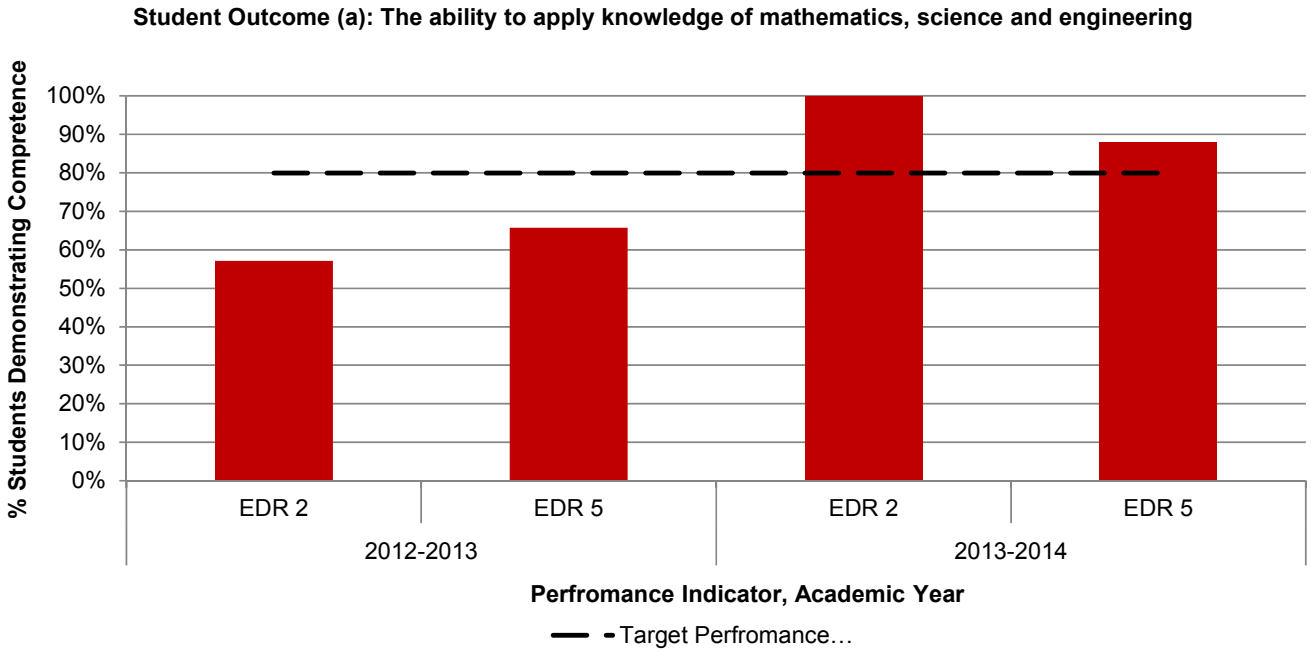


Figure 4-4. Student Outcome (a) results for 2012-2104.

Outcome A

Outcome A: Intermediate Assessment Plan Annual Evaluation Summary

Summary of Evaluation Process: Summative data for Student Outcome (a) is measured by four assessment instruments. The first assessment rubric, EDR 2, which is defined by the ability to use multiple strategies, approaches, and materials, to generate a variety of ideas and alternatives to systematically explore possible solution paths. The students' ability in this area was measured in CEE 464 using the students' project proposal for their senior design project. The second assessment rubric, EDR 5, focuses on engineering analysis and design which is defined by the students' ability to skillfully synthesize the results of modeling, simulation, and prototyping to refine the design and/or reformulate the problem. The students' ability in this area was measured with EDR 5 in CEE 465 using the students' second and third progress reports for their senior design project as well as their final report. In addition to course data FE exam topics related to Outcome (a): Mathematics, Statics, Dynamics, Mechanics of Materials, Materials, Fluid Mechanics, and Structural Analysis were used to assess Outcome (a).

2012-13

Results/Observations: This was the initial deployment of this assessment process and rubrics. Student performance as assessed using these two rubrics fell below our target level (80% of students meeting or exceeding the expectation of performance at the "competent" level or "3" on a scale of 0 – 5). We anticipate that increased faculty and student exposure and use of the engineering design assessment concepts and rubrics will improve results. In addition, future measurements will be performed by faculty assessment teams who will undergo a calibration process to develop inter-rater reliability and increase the validity of the assessment. Students did not meet expectations for any of the seven FE topic areas related to Outcome (a).

Actions:

1) Performance indicators should be introduced in the context of the assessment rubrics (EDR 2 and 5) in supporting courses. Faculty will be trained on the use of the rubrics and underlying principles in the fall semester.
2) Ensure curriculum is aligned with FE content.
3) Include FE exam preparation and review as part of CEE 463.

2013-14

Results/Observations: Student performance as assessed using these two rubrics was well above our target level (80% of students meeting or exceeding the expectation of performance at the "competent" level or "3" on a scale of 0 – 5). This is largely due to faculty and students understanding the assessment rubrics and expectations (see Action item 1 from 2012-13). In response to 2012-13 action item 2 a list of FE topics and corresponding courses was created and presented in a faculty meeting in which the appropriate course was identified for each FE topic. This list is available in the supplemental materials for Outcome (a). This list is also used in CEE 130 and CEE 463 in preparing students for the FE exam. This year's FE exam results showed a significant improvement over 2012-13, with students exceeding the national average in 3 of the 7 FE topics related to Outcome (a)

Actions:

1) Continue FE review in CEE 463 and require students to take the online practice exam as part of CEE 463.

Outcome A

Current Assessment Plan (2011and 2014-2016)

This section presents the results from the Current Assessment plan (2011 and 2014-2106). Data sources related to each performance indicator along with assessment instruments are provided in Table 4-25. The rubric used to evaluate each instrument in given in Table 4-26. A bar graph showing the percentage of students who met or exceeded expectations for each of the performance indicators is shown in Figure 4-5. A summary of the annual assessment results/observations as well as action items for continuous improvement are provided.

Table 4-25. Outcome A: Data Sources 2011-12, 2014-15, and 2015-16

Performance Indicators	Rubric	Source: Instrument
1. Apply math and science to understands engineering principles	Rubric (a)	CEE 353: Select Exam Questions EM 331: Select Exam Questions EM 321: Select Exam Questions
2. Apply engineering principles to solve design/analysis problems	Rubric (a)	CEE 353: Select Exam Questions EM 331: Select Exam Questions EM 321: Select Exam Questions

Table 4-26. Outcome A Assessment Rubric

a. An ability to apply knowledge of mathematics, science, and engineering.

Performance Indicators	Below expectations 1 (50%-63%)	Minimally acceptable 2 (63%-75%)	Meets expectations 3 (75%-88%)	Exceeds expectations 4 (88%-100%)
1. Apply math and science to understand engineering principles	Poor understanding of math and science principles	Understanding of math and science principles with minimal ability to apply to engineering problems	Understanding of math and science principles with ability to apply to engineering problems	Understanding of math and science principles with minimal ability to apply to engineering problems with minimal or no errors
2. Apply engineering principles to solve design/analysis problems	Poor understanding of engineering principles	Understanding of engineering principles with minimal ability to apply to engineering problems	Understanding of engineering principles with ability to apply to engineering problems	Understanding of engineering principles with minimal ability to apply to engineering problems with minimal or no errors

Outcome A

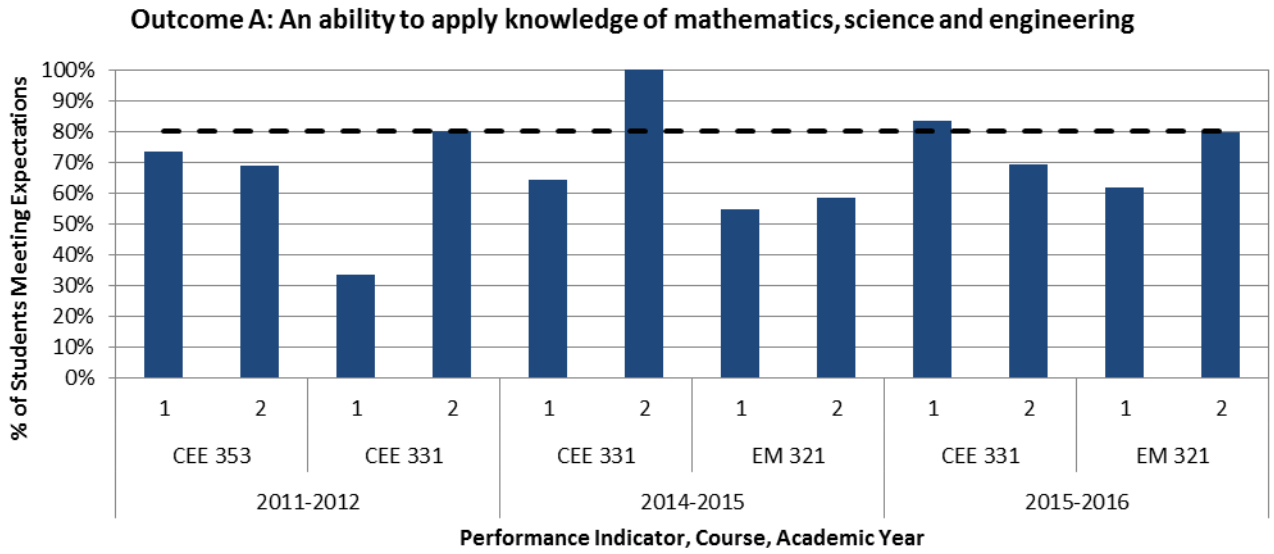


Figure 4-5. Student Outcome (a) results for 2011 and 2014-2016.

Outcome A

Outcome A: Current Assessment Plan Annual Evaluation Summary

Summary of Evaluation Process: Summative data for Student Outcome (a), the ability to apply knowledge of mathematics, science, and engineering, is measured using rubric (a) developed by the faculty. The data was primarily obtained from select exam questions administered in EM 321 (Mechanics of Materials) and EM 331 (Fluid Mechanics). These problems were selected to allow the students to demonstrate 1) there ability to apply math and science principles to engineering and 2) to apply engineering principles to solve design/analysis problems. Students who scored 3 or higher (75%) based on rubric (a) were deemed to meet or exceed expectations. The department goal is to have 80% of the students meet or exceed expectations. In addition to course data, FE exam topics related to Outcome (a): Mathematics, Statics, Dynamics, Mechanics of Materials, Materials, Fluid Mechanics, and Structural Analysis were used to assess Outcome (a) were used in the assessment. A summary of the results/observations and action items recommended by the faculty during the annual assessment meetings are presented.

2014-15

Results/Observations: Based on the assessments performed in Mechanics of Materials (EM 321) and Fluid Mechanics (EM 331) only 61% of students met or exceeded expectations. This is below our department goal of 80%. In response to these results faculty who teach the engineering mechanics courses met to discuss how they could better prepare students. The result of the meeting was an agreement to hold students to a high standard to assure they understand the material and to provide additional review sessions outside of classes. A graduate student (Chris Timm) offered review sessions for Statics (EM 214) and Fluid Mechanics (EM 331) spring 2015. Review sessions were offered two to three days per week as well as exam review sessions. Attendance was 6-12 students at each session. Students exceeded the FE national averages for 4 of the 7 topics related to outcome (a) which is an improvement over the past two years and may likely be a result of the FE review sessions in CEE 463 and requirement to take the computer based practice FE exam.

Actions:

1) Continue review sessions for EM 214 and EM 331 and add review sessions for EM 321.
2) Continue to require students to take the practice FE exam in CEE 463.
3) Require Dynamics (ME 211) for CE students in preparation for the FE exam (curriculum change).
4) Emphasize the importance of EM 214, 321, and 331 to underclassman. Treat these courses as gateway courses for which students must show competence ("C" grade) to continue on.

2015-16

Results/Observations: Based on assessments performed in Mechanics of Materials (EM 321) and Fluid Mechanics (EM 331) 72% of students met or exceeded expectations which was an improvement over 2014-15. This is still below our department goal of 80%. Attendance for statics review sessions increased from 6-12 students (2014-15) to 40-50 students (2015-16) for exam review sessions. The review sessions were conducted by the Wayne Echelberger CEE Honors Society. There was concern expressed regarding maturity level and math background of students. Senior exit surveys suggested showing applications of principles earlier in the curriculum to better engage students in basic engineering courses such as EM 214, EM 321, and EM 331.

Actions:

1) Continue exam review sessions with WECEE for EM 214, 321, and 331.
2) Provide real world examples/hands on activities to engage students-this was recommended by the students in the Senior Exit Survey. Robinson to send reminder to Faculty of these courses fall 2016.

Outcome B

An ability to design and conduct experiments, as well as to analyze and interpret data

A summary of the percentage of students meeting or exceeding expectations over the review period (2011-2016) is given in Table 4-27 followed by a summary of the FE exam results related to outcome (b) in Table 4-28 with plotted results provided in Figure 4-4-6**.** Subsequent sections present the assessment results from the intermediate assessment and the current assessment plans along with assessment results/observations and action plans for continuous improvement.

Table 4-27. Outcome (b) Summary 2011-2016

Student Outcome	2011-2012	2012 – 2013*	2013 – 2014*	2014 – 2015	2015 – 2016
(b)	86%	63%	74%	98%	91%
	80%-100% of students meet or exceed expectations				
	70%-80% of students meet or exceed expectations				
	60%-70% of students meet or exceed expectations				
	Less than 60% of students meet or exceed expectations				

*Intermediate assessment plan results.

FE Results

Table 4-28. FE Topics related to Outcome (b) 2010-2016

FE Topic	Outcome	Courses	10/11	11/12	12/13	13/14	14/15	F15*
Probability and Statistics	(b)	MATH 381 CEE 284	0.85	0.80	0.86	0.94	0.85	1.13
	Greater than 1.0							
	0.9 to 1.0							
	0.8 to 0.9							
	Less than 0.8							

*Data is for only a single semester

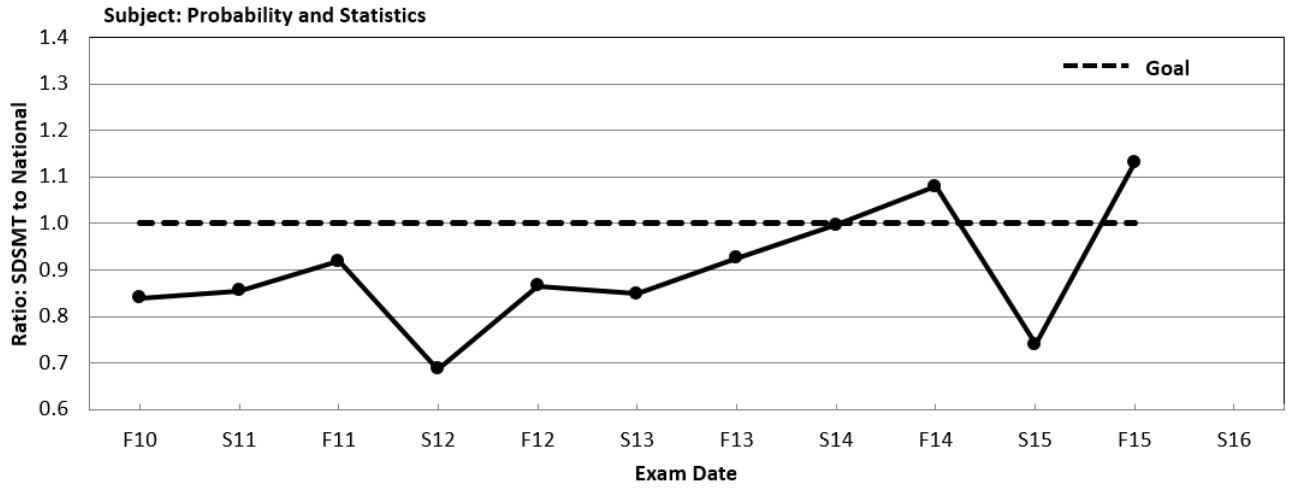


Figure 4-4-6. Plots of FE results for each semester from 2010-2016 for Probability and Statistics.

Outcome B

Intermediate Plan Results (2012-13 and 2013-14)

This section presents the results from the Intermediate Assessment plan (2012-2014). Data sources related to each performance indicator along with assessment instruments are provided in Table 4-29. A bar graph showing the percentage of students who met or exceeded expectations for each of the performance indicators is shown in Figure 4-7. A summary of the annual assessment results/observations as well as action items for continuous improvement are provided.

Table 4-29. Outcome (b) Data Sources 2012-2014

Performance Indicator	Rubric	Source: Instrument
1. Impact analysis	EDR 3	CEE 464: Progress report #1
2. Design development/concept generation	EDR 4	CEE 464/465: Progress report #1 & #2
3. Engineering analysis and design	EDR 5	CEE 465: Progress Report #2 & #3, final report

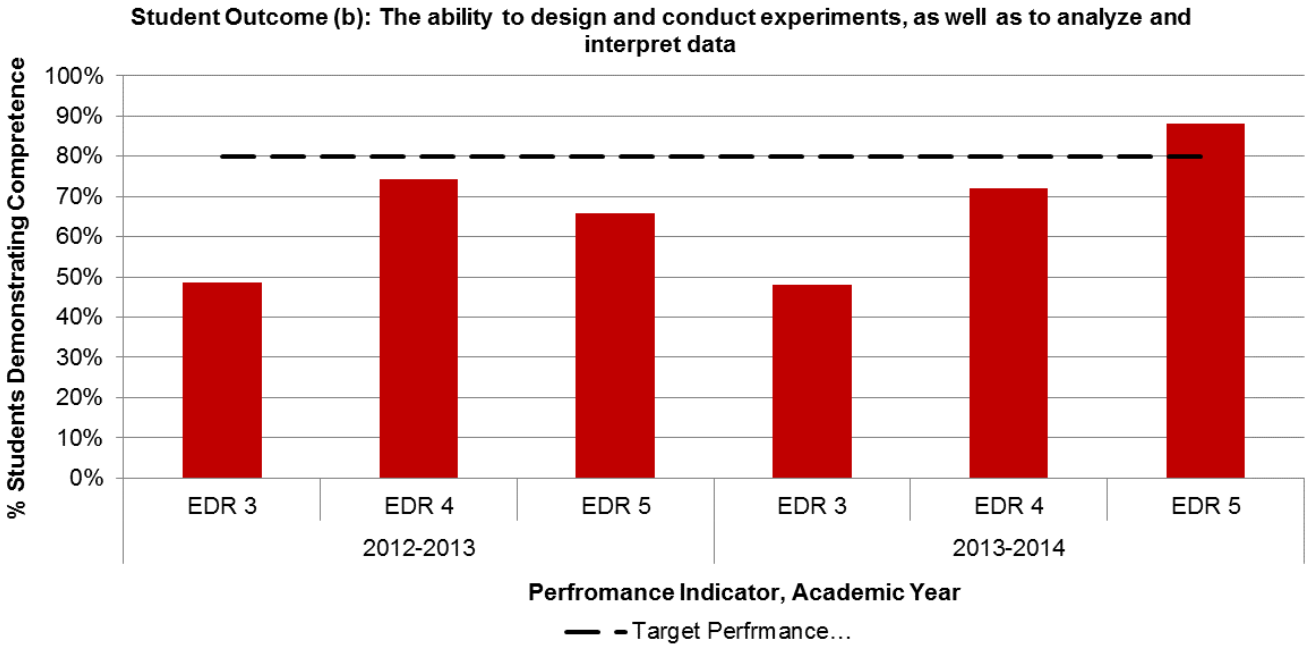


Figure 4-7. Student Outcome (b) results for 2012-2014.

Outcome B

Outcome B: ***Intermediate Assessment Plan Annual Evaluation Summary***

Summary of Evaluation Process: Summative data for Student Outcome (b), the ability to design and conduct experiments, as well as to analyze and interpret data, is measured by three assessment instruments. The first assessment rubric, EDR 3, focuses on impact analysis which is defined as the student's consideration of the relevant impacts of the design in ethical, global, economic, societal, cultural, and environmental contexts. Students shall clearly show how relevant considerations have influenced target technical specifications and alternatives that were identified in the proposal. The students' ability in this area was measured in CEE 464 using the students' first progress report for their senior design project. The second assessment rubric, EDR 4, focuses on design synthesis and concept selection which is defined as the student's ability to methodically narrow down design choices in ways that refine concepts and lead to focusing on the most promising design solutions that incorporate relevant considerations identified in the Impact Analysis. The students' ability in this area was measured in CEE 464/465 using the students' first and second progress report for their senior design project. The third assessment rubric, EDR 5, focuses on engineering analysis and design which is defined as the student's ability to skillfully synthesize the results of modeling, simulation, and prototyping to define the design and/or reformulate the problem. The students' ability in this area was measured in CEE 465 using the students' second and third progress report for their senior design project as well as their final report.

2012-13

Results/Observations: The capstone design course, CEE 465, was comprised of 35 students divided into eight teams. The performance of these 35 students (100% of the class) was assessed individually by the instructor, Dr. Damon Fick. 49% of the students met or exceeded expectations for Rubric 1 (EDR 3). 74% of the students met or exceeded expectations for Rubric 2 (EDR 4). 66% of the students met or exceeded expectations for Rubric 3 (EDR 5). This was the initial use of these assessment rubrics. Student results fell below our target level (80% of students meeting or exceeding the expectation of performance at the "competent" level or "3" on a scale of 0 – 5). We anticipate that increased exposure of both faculty and students to the engineering design assessment concepts and rubrics will improve results. Future measurements will be performed by faculty assessment teams who will undergo a calibration process to develop inter-rater reliability and increase the validity of the assessment.

Actions:

1) Performance indicators should be introduced in the context of the assessment rubrics in supporting courses. Faculty will be trained on the use of the rubrics and underlying principles in the fall semester.

2013-14

Results/Observations: Although there was an improvement (74% of students meeting or exceeding expectations) in comparison to 2012-13 we still did not reach the department goal of 80%. This outcome is not well suited for Capstone Design and should be measured in more relevant courses.

Actions:

1) Measure outcome (b) in relevant lab courses in which student perform experiments.

Outcome B

Current Plan Results (2011-12, 2014-15, and 2015-16)

This section presents the results from the Current Assessment plan (2011 and 2014-2106). Data sources related to each performance indicator along with assessment instruments are provided in Table 4-30. The rubric used to evaluate each instrument in given in Table 4-31. A bar graph showing the percentage of students who met or exceeded expectations for each of the performance indicators is shown in Figure 4-8. A summary of the annual assessment results/observations as well as action items for continuous improvement are provided.

Table 4-30. Outcome (b) Data Sources 2011-12 and 2014-2016

Performance Indicator	Rubric	Source: Instrument
1. Develop and implement an experimental protocol in a laboratory or field	Rubric (b)	CEE 316L: Project CEE 346L: CEE 327L: Lab Report
2. Analyze data and test results	Rubric (b)	CEE 316L: Lab Report/Homework CEE 346L: CEE 327L
3. Interpret data and test results	Rubric (b)	CEE 316L: Lab Report/Homework CEE 346L: CEE 327L: Lab Report

Table 4-31. Outcome B Assessment Rubric

b. An ability to design and conduct experiments, as well as to analyze and interpret data.

Performance Indicators	Below expectations 1 (50%-63%)	Minimally acceptable 2 (63%-75%)	Meets expectations 3 (75%-88%)	Exceeds expectations 4 (88%-100%)
1. Develop and implement an experimental protocol in a laboratory or field setting	Cursory effort, little definition of apparatus or materials	Some definition of materials, inaccuracies prevalent	Substantial definition of apparatus and materials, mostly accurate	Full definition of apparatus and materials
2. Analyze data and test results	No or rudimentary analysis employed	Some analyses completed, largely incorrect or omitted	Substantial analysis employed, with some errors/omissions	Clear, complete, correct analysis
3. Interpret data and test results	Conclusions missing or completely off the mark	Some correct conclusion drawn from data analysis	Substantially correct conclusions drawn from data analysis	Fully correct conclusions drawn from data analysis

Outcome B

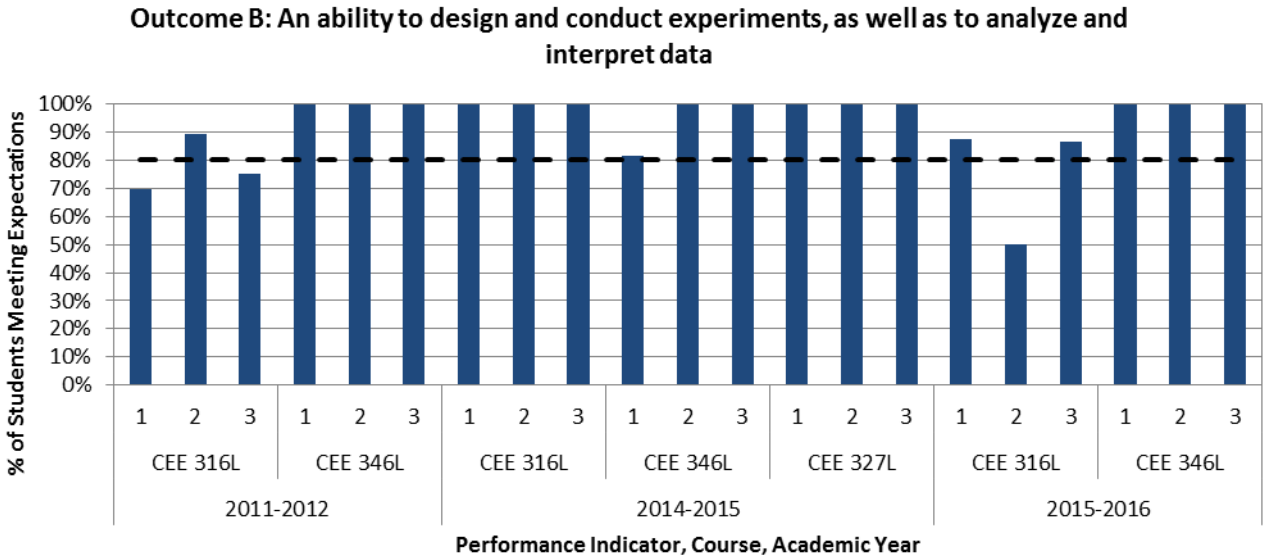


Figure 4-8. Student Outcome (b) results for 2011 and 2014-2016.

Outcome B

Outcome B: Current Assessment Plan Annual Evaluation Summary

Summary of Evaluation Process: Summative data for Student Outcome (b), the ability to design and conduct experiments, as well as to analyze and interpret data, is measured using rubric (b) developed by the faculty. The data was primarily obtained from lab reports, projects, and homework from lab courses (CEE 316L, CEE 327L, and CEE 346L). These assignments were selected to allow the students to demonstrate 1) there ability to develop and implement an experimental protocol in a laboratory or field, 2) analyze data and test results, and 3) interpret data and test results. Students who scored 3 or higher (75%) based on rubric (b) were deemed to meet or exceed expectations. The department goal is to have 80% of the students meet or exceed expectations. In addition to course data, FE exam topics related to Outcome (b): Probability and Statistics were used in the assessment. A summary of the previous actions, observations, and new action items recommended by the faculty during the annual assessment meetings are presented.

2014-15 (98%)

Previous Actions: Recommend Math 381 beginning Fall 2013 and required beginning Fall 2014

Observations:

98% of students met expectations. Currently instruments consist of group lab reports which may not be representative of individual performance. It was recommended that each indicator be measured by individual performance rather than team work. This could be done by the following:

1. Provide a hypothetical problem and ask individual students to develop an experimental protocol to test a hypothesis.
2. Provide students with a set of data and ask them to determine statistical information for the data set.
3. Based on the statistical information ask students to interpret the data.

These problems should be incorporated into an exam. FE results show an improvement. This is likely due to the recommendation/requirement of MATH 381 (Probability and Statistics).

Consider measuring in CEE 337 in the future. This course has a significant amount of probability and statistics. Indicators 2 and 3 could also be measured in CEE 284.

New Actions: Provide individual assessments for each indicator by:

1. Provide a hypothetical problem and ask individual students to develop an experimental protocol to test a hypothesis.
2. Provide students with a set of data and ask them to determine statistical information for the data set.
3. Based on the statistical information ask students to interpret the data.

2015-16 (91%)

Previous Actions: Provide individual assessments for each indicator by:

1. Provide a hypothetical problem and ask individual students to develop an experimental protocol to test a hypothesis.
2. Provide students with a set of data and ask them to determine statistical information for the data set.
3. Based on the statistical information ask students to interpret the data.

Observations:

1. In CEE 346L a problem was given to develop an experimental protocol but students still worked in groups.
2. In CEE 316 students were given a homework problem consisting of statistics. Students did not meet expectation for this indicator. These topics are covered in CEE 284.

New Actions: Move Math 381 earlier in the curriculum to better prepare students for CE labs which utilize statistics
Consider assessing in CEE 284 and CEE 336L

Outcome C

An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability

A summary of the percentage of students meeting or exceeding expectations over the review period (2011-2016) is given in Table 4-32**.** Subsequent sections present the assessment results from the intermediate assessment and the current assessment plans along with assessment results/observations and action plans for continuous improvement.

Table 4-32. Outcome (c) Summary 2011-2016

Student Outcome	2011-2012	2012 – 2013	2013 – 2014	2014 – 2015	2015 – 2016
(c)	55%	61%	80%	78%	89%
	80%-100% of students meet or exceed expectations				
	70%-80% of students meet or exceed expectations				
	60%-70% of students meet or exceed expectations				
	Less than 60% of students meet or exceed expectations				

Outcome C

Intermediate Plan Results (2012-13 and 2013-14)

This section presents the results from the Intermediate Assessment plan (2012-2014). Data sources related to each performance indicator along with assessment instruments are provided in Table 4-33. A bar graph showing the percentage of students who met or exceeded expectations for each of the performance indicators is shown in Figure 4-9. A summary of the annual assessment results/observations as well as action items for continuous improvement are provided.

Table 4-33. Outcome (c) Data Sources 2012-2014

Performance Indicator	Rubric	Source: Instrument
1. Design development/concept generation	EDR 2	CEE 464: Project proposal
2. Impact analysis	EDR 3	CEE 464: First progress report
3. Design development/concept selection	EDR 4	CEE 464/465: Progress report #1 & #2
4. Engineering analysis and design	EDR 5	CEE 465: Progress report #2 & #3; final report

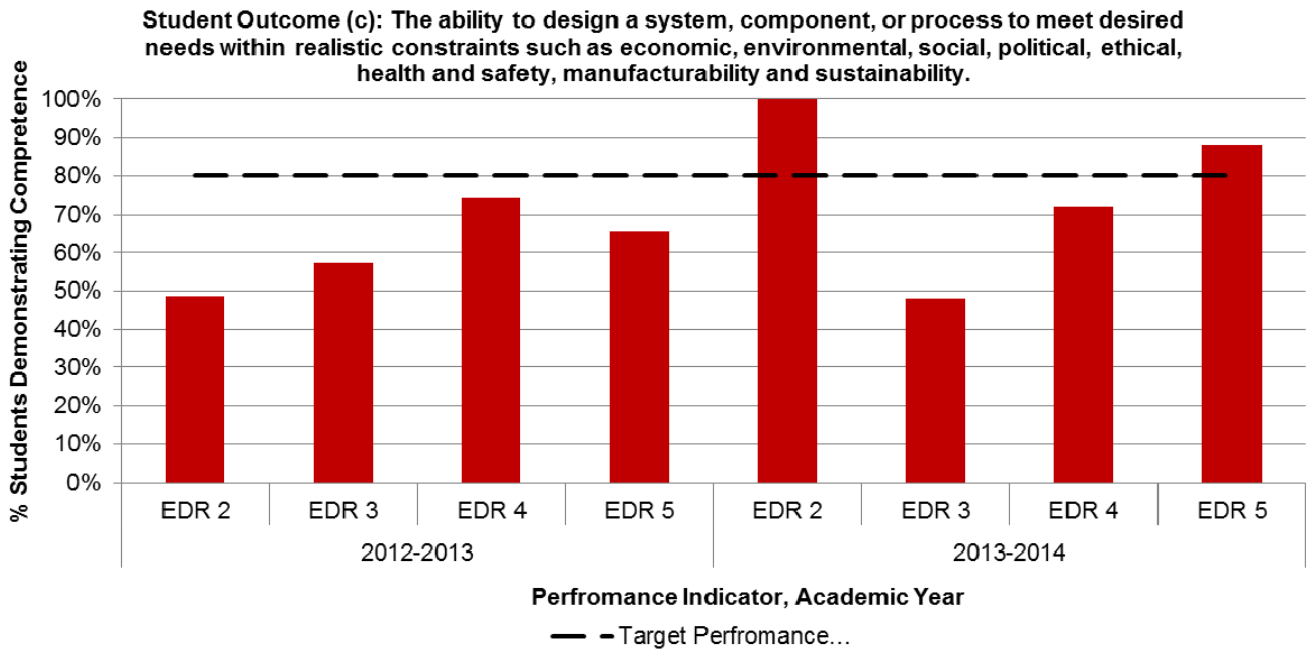


Figure 4-9. Student Outcome (c) results for 2012-2014.

Outcome C

Outcome C: Intermediate Assessment Plan Annual Evaluation Summary

Summary of Evaluation Process: Summative data for Student Outcome (c), the ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability, is measured by four assessment instruments. The first assessment rubric, EDR 2, focuses on design synthesis and concept generation which is defined as the student's ability to uses multiple strategies, approaches, and materials, to generate a variety of ideas and alternatives to systematically explore possible solution paths. The students' ability in this area was measured in CEE 464 using the students' project proposal for their senior design project. The second assessment rubric, EDR 3, focuses on impact analysis which is defined as the student's consideration of the relevant impacts of the design in ethical, global, economic, societal, cultural, and environmental contexts. Students shall clearly show how relevant considerations have influenced target technical specifications and alternatives that were identified in the proposal. The students' ability in this area was measured in CEE 464 using the students' first progress report for their senior design project. The third assessment rubric, EDR 4, focuses on design synthesis and concept selection which is defined as the student's ability to methodically narrow down design choices in ways that refine concepts and lead to focusing on the most promising design solutions that incorporate relevant considerations identified in the Impact Analysis. The students' ability in this area was measured in CEE 464/465 using the students' first and second progress report for their senior design project. The fourth assessment rubric, EDR 5, focuses on engineering analysis and design which is defined as the student's ability to skillfully synthesize the results of modeling, simulation, and prototyping to define the design and/or reformulate the problem. The students' ability in this area was measured in CEE 465 using the students' second and third progress report for their senior design project as well as their final report.

2012-13

Results/Observations: This was the initial use of these assessment rubrics. Student results fell below our target level of 80% of students meeting or exceeding the expectation of performance at the "competent" level or "3" on a scale of 0 – 5. We anticipate that increased exposure of both faculty and students to the engineering design assessment concepts and rubrics will improve results. Future measurements will be performed by faculty assessment teams who will undergo a calibration process to develop inter-rater reliability and increase the validity of the assessment.

Actions: Performance indicators should be introduced in the context of the assessment rubrics (EDR 2, 3, 4 and 5) in supporting courses. Faculty will be trained on the use of the rubrics and underlying principles in the fall semester. Faculty will report on the results of their implementation at the end of the fall semester assessment meeting.

2013-14

Results/Observations: Providing assessment rubrics to students resulted in a significant increase in the number of students meeting expectations. In order to get a better understanding of the curriculum as a whole it is recommended to go back to the original assessment plan developed in 2010 in which assessments were conducted using courses from across the curriculum.

Actions:

1) Revert back to previous assessment plan.

Outcome C

Current Plan Results (2011-12, 2014-15, and 2015-16)

This section presents the results from the Current Assessment plan (2011 and 2014-2106). Data sources related to each performance indicator along with assessment instruments are provided in Table 4-34. The rubric used to evaluate each instrument in given in Table 4-35. A bar graph showing the percentage of students who met or exceeded expectations for each of the performance indicators is shown in Figure 4-10. A summary of the annual assessment results/observations as well as action items for continuous improvement are provided.

Table 4-34. Outcome (c) Data Sources 2011 and 2014-2016

Performance Indicator	Rubric	Source: Instrument
1. Determine appropriate performance and design criteria	Rubric (c)	CEE 336: Project CEE 325: Project CEE 489: Final Report (EDR 2-5)
2. Identify technical and non-technical constraints governing design	Rubric (c)	CEE 336: Project CEE 325: Project CEE 489: Final Report (EDR 2-5)
3. Perform the analysis and select the appropriate design	Rubric (c)	CEE 336: Project CEE 325: Project CEE 489: Final Report (EDR 2-5)

Table 4-35. Outcome C Assessment Rubric

c. An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

Performance Indicators	Below expectations 1 (50%-63%)	Minimally acceptable 2 (63%-75%)	Meets expectations 3 (75%-88%)	Exceeds expectations 4 (88%-100%)
1. Determine appropriate performance and design criteria	Performance characteristics of product/result undefined	Partial definition of performance characteristics of product/result -- significant errors or omissions	Substantial definition of performance characteristics of product/result -- few errors or omissions	Complete definition of performance characteristics of product/result
2. Identify technical and non-technical constraints governing the design	Unable to define constraints	Partial definition of constraints	Substantial definition of constraints	Constraints fully defined and appraised
3. Perform the analysis and select the appropriate design	No numeric evaluation of design	Designs only partially evaluated	One or more alternatives fully evaluated -- numeric results obtained for one or more alternative	Full evaluation of several relevant potential alternative designs -- numeric results obtained for all

Outcome C

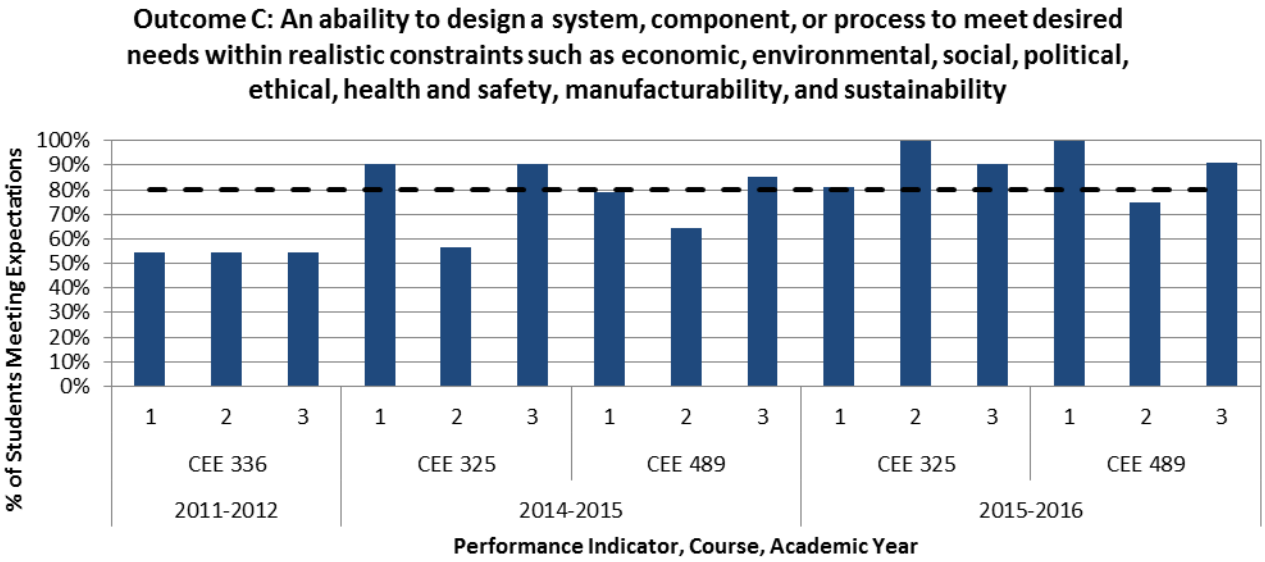


Figure 4-10. Student Outcome (c) results for 2011 and 2014-2016.

Outcome C

Outcome C: Current Assessment Plan Annual Evaluation Summary

Summary of Evaluation Process: Summative data for Student Outcome (c), an ability to design a system component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability and sustainability, is measured using rubric (c) developed by the faculty. The data was primarily obtained from projects and reports in CEE 336, CEE 325, and CEE 489. Students who scored 3 or higher (75%) based on rubric (c) were deemed to meet or exceed expectations. The department goal is to have 80% of the students meet or exceed expectations. A summary of the previous actions, observations, and new action items recommended by the faculty during the annual assessment meetings are presented.

2014-15

Previous Actions:
Spring 2014 provided assessment rubrics to students in CEE 489.

Observations:
This outcome is also measured from team projects. The sentiment of the faculty is that our students are not well versed in contemporary issues that affect engineering decisions.

New Actions:
Bring contemporary issues into the classroom. Make this a goal for all courses beginning fall 2015.
Invite Dan Dolan into CEE 489 to discuss open ended problems.

2015-16

Previous Actions:
1. Bring contemporary issues which control engineering design into the classroom. Make this a goal for all courses beginning fall 2015.
2. Invite Dan Dolan into CEE 489 to discuss open ended problems.

Observations:
1. Dan Dolan came into CEE 489 and discussed open ended problems. Students commented that this was the 2nd or third time they heard the presentation.
2. In Capstone Design students were asking for technical help without seeking information in advance.

New Actions:
Continue bringing contemporary issues which control engineering design into the classroom.

Outcome D

An ability to function on multi-disciplinary teams

A summary of the percentage of students meeting or exceeding expectations over the review period (2011-2016) is given in Table 4-36**.** Subsequent sections present the assessment results from the intermediate assessment and the current assessment plans along with assessment results/observations and action plans for continuous improvement.

Table 4-36. Outcome (d) Summary 2011-2016

Student Outcome	2011-2012	2012 – 2013	2013 – 2014	2014 – 2015	2015 – 2016
(d)	---	67%	86%	86%	95%
	80%-100% of students meet or exceed expectations				
	70%-80% of students meet or exceed expectations				
	60%-70% of students meet or exceed expectations				
	Less than 60% of students meet or exceed expectations				

Outcome D

Intermediate Plan Results (2012-13 and 2013-14)

This section presents the results from the Intermediate Assessment plan (2012-2014). Data sources related to each performance indicator along with assessment instruments are provided in Table 4-37. A bar graph showing the percentage of students who met or exceeded expectations for each of the performance indicators is shown in Figure 4-11. A summary of the annual assessment results/observations as well as action items for continuous improvement are provided.

Table 4-37. Outcome (d) Data Sources 2012-2014

Performance Indicator	Rubric	Source: Instrument
1. Design development/concept generation	EDR 2	CEE 464:Project Proposal
2. Design development/concept selection	EDR 4	CEE 465:Progress report #1 & #2
3. Group interaction, group self-regulation	EPSA 2	CEE 463:EPSA discussion

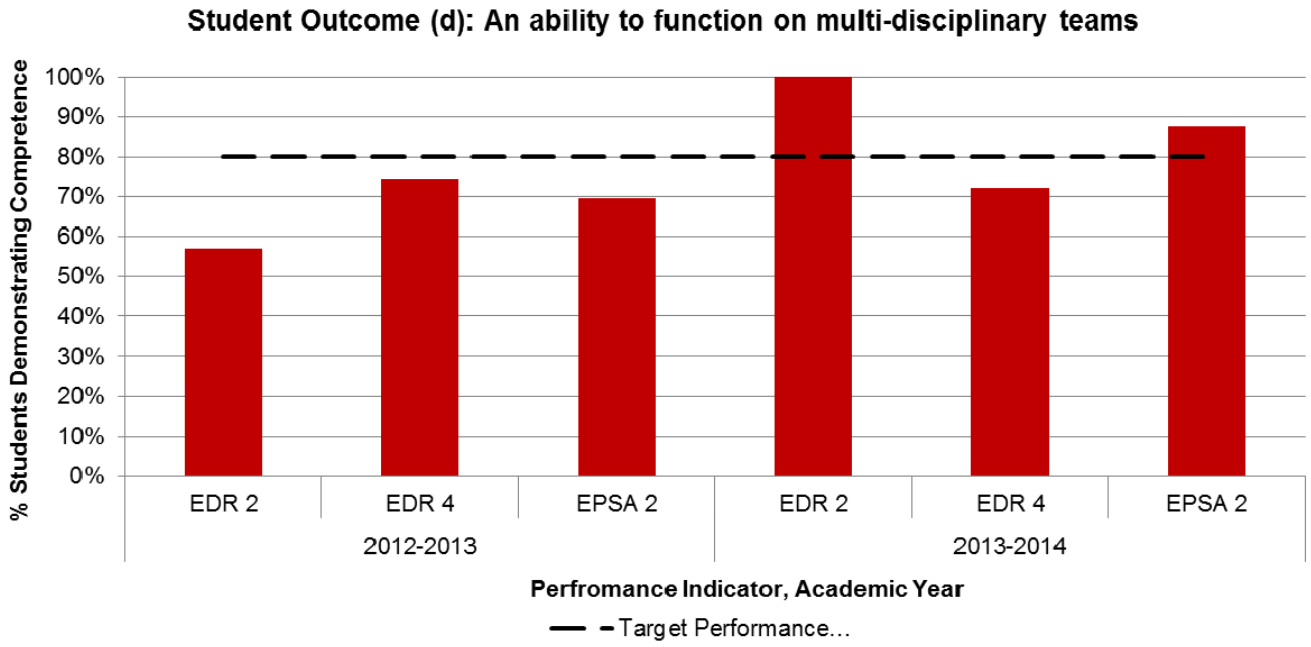


Figure 4-11. Student Outcome (d) results for 2012-2014.

Outcome D

Outcome D: Intermediate Assessment Plan Annual Evaluation Summary

Summary of Evaluation Process: Summative data for Student Outcome (d), the student's ability to function on multi-disciplinary teams, is measured by four assessment instruments. The first assessment rubric, EDR 2, focuses on design synthesis and concept generation which is defined as the student's ability to uses multiple strategies, approaches, and materials, to generate a variety of ideas and alternatives to systematically explore possible solution paths. The students' ability in this area was measured in CEE 464 using the students' project proposal for their senior design project. The second assessment rubric, EDR 4, focuses on design synthesis and concept selection which is defined as the student's ability to methodically narrow down design choices in ways that refine concepts and lead to focusing on the most promising design solutions that incorporate relevant considerations identified in the Impact Analysis. The students' ability in this area was measured in CEE 464/465 using the students' first and second progress report for their senior design project. The third assessment rubric, EPSA 2, focuses on group interaction and group self-regulation which is defined as the student's ability to clearly encourage participation from all group members, generate ideas together and actively help each other clarify ideas as well as work together to reach a consensus in order to clearly frame the problems and develop appropriate, concrete ways to resolve the problems. The students' ability in this area was measured in CEE 463 using the students' EPSA discussion topic.

Results/Observations: The capstone design course, CEE 465, was comprised of 35 students divided into eight teams. The performance of these 35 students (100% of the class) was assessed individually by the instructor, Dr. Damon Fick. 57% of the students met or exceeded expectations for Rubric 1 (EDR 2). 74% of the students met or exceeded expectations for Rubric 2 (EDR 4). The CEE 463 course was comprised of a total of 23 students who were individually assessed by instructors Dr. Scott Amos and Dr. Marc Robinson. 70% of the students met or exceeded expectations for Rubric 3 (EPSA 2). This was the initial deployment of these assessment rubrics. Two of the five assessment rubrics (50%) fell below our target level of 80% of students meeting or exceeding the expectation of performance at the "competent" level or "3" on a scale of 0 – 5. We anticipate that increased exposure of both faculty and students to the engineering design assessment concepts and rubrics will improve results. Future measurements will be performed by faculty assessment teams who will undergo a calibration process to develop inter-rater reliability and increase the validity of the assessment.

Actions: Performance indicators should be introduced in the context of the assessment rubrics (EDR 2 & 4) in supporting courses. Faculty will be trained on the use of the rubrics and underlying principles in the fall semester. Faculty will report on the results of their implementation at the end of the fall semester assessment meeting.

2013-14

Results/Observations: Providing assessment rubrics to students resulted in a significant increase in the number of students meeting expectations. In order to get a better understanding of the curriculum as a whole it is recommended to go back to the previous assessment plan developed in 2010 in which assessments were conducted using courses from across the curriculum.

Actions:

1) Revert back to previous assessment plan.

Outcome D

Current Plan Results (2011-12, 2014-15, and 2015-16)

This section presents the results from the Current Assessment plan (2011 and 2014-2106). Data sources related to each performance indicator along with assessment instruments are provided in Table 4-38. The rubric used to evaluate each instrument in given in Table 4-39. CATME (Comprehensive Assessment of Team Members Effectiveness) is an online team building and assessment tool developed for faculty. Through CATME students are able to anonymously evaluate their own performance as well as that of their teammates. A bar graph showing the percentage of students who met or exceeded expectations for each of the performance indicators is shown in Figure 4-12. A summary of the annual assessment results/observations as well as action items for continuous improvement are provided.

Table 4-38. Outcome (d) Data Sources 2011 and 2014-2016

Performance Indicator	Rubric	Source: Instrument
1. Contribute high quality work	Rubric (d)	CEE 325: CATME Questions C and E CEE 489: CATME Questions C and E
2. Effectively work with others	Rubric (d)	CEE 325: CATME Questions I and K CEE 489: CATME Questions I and K

Table 4-39. Outcome D Assessment Rubric

d. An ability to function on multi-disciplinary teams.

Performance Indicators	Below expectations 1 (50%-63%) CATME 1-2	Minimally acceptable 2 (63%-75%) CATME 2-3.5	Meets expectations 3 (75%-88%) CATME 3.5-4	Exceeds expectations 4 (88%-100%) CATME 4-5
1. Contribute high quality work	Contributing to teams work (1-2), Expecting quality (1-2)	Contributing to teams work (2-3.5), Expecting quality (2-3.5)	Contributing to teams work (3.5-4), Expecting quality (3.5-4)	Contributing to teams work (4-5), Expecting quality (4-5)
2. Effectively work with others	Interacting with teammates (1-2), Keeping the team on track (1-2)	Interacting with teammates (2-3.5), Keeping the team on track (2-3.5)	Interacting with teammates (3-4), Keeping the team on track (3.5-4)	Interacting with teammates (4-5), Keeping the team on track (4-5)

Outcome D

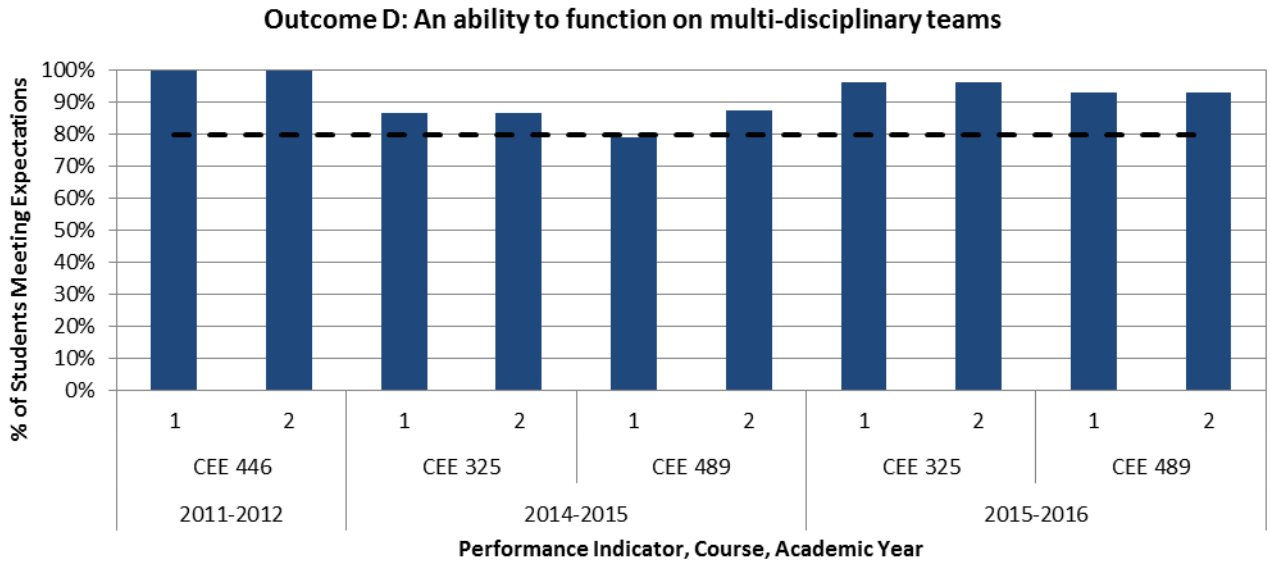


Figure 4-12. Student Outcome (d) results for 2011 and 2014-2016.

Outcome D

Outcome D: Current Assessment Plan Annual Evaluation Summary

Summary of Evaluation Process: Summative data for Student Outcome (d), an ability to function on multi-disciplinary teams, is measured using rubric (d) developed by the faculty. The data was obtained from CATME surveys in, CEE 325, and CEE 489. Students who scored 3.5 or higher on the CATME survey specific topics were deemed to meet or exceed expectations. The department goal is to have 80% of the students meet or exceed expectations. A summary of the previous actions, observations, and new action items recommended by the faculty during the annual assessment meetings are presented.

2014-15 (86% of students met expectations)

Previous Actions: None

Observations:

Assessment based on CATME survey results (3.5 or above meets expectations). Based on Instructor observations for CEE 325 and CEE 489, a score of 3.5 from the CATME survey represented "meeting expectations" in teaming.

Some CEE 489 senior design projects showed minimal multi-disciplinary content.

New Actions:

1. Define CEE 489 projects which cover multiple sub disciplines of CE.
2. Provide more design teaming opportunities throughout the curriculum.
3. Invite Dan Dolan into CEE 489 to discuss open ended problems.
4. Grading CEE 206 and 474 emphasis
5. Align CEE 474 topics with CEE 489. Scheduling, grading, cost estimating.

2015-16 (95% of students met expectations)

Previous Actions:

1. Define CEE 489 projects which cover multiple sub disciplines of CE.
2. Provide more design teaming opportunities throughout the curriculum.
3. Invite Dan Dolan into CEE 489 to discuss open ended problems.
4. Cover site grading in CEE 206 and 474 emphasis
5. Align CEE 474 topics with CEE 489. Scheduling, grading, cost estimating.

Observations:

1. Capstone Design students commented on helpfulness of CEE 474 topics relations to design project.
2. Exit survey students commented that teaming is one way they met PEOs through the CE curriculum.
3. Are we teaching teaming/management in the curriculum?
4. CEE 346 will be covering teaming topics as part of the curriculum
5. Review coverage of CEE 130.
6. Consider contracts for CEE 489

New Actions:

1. In CEE 346 beginning fall 2017 teaming topics will be introduced as part of the course.

Outcome E

An ability to identify, formulate, and solve engineering problems

A summary of the percentage of students meeting or exceeding expectations over the review period (2011-2016) is given in Table 4-40 followed by a summary of the FE exam results related to outcome (e) in Table 4-41 with plotted results provided in Figure 4-4-13**.** Subsequent sections present the assessment results from the intermediate assessment and the current assessment plans along with assessment results/observations and action plans for continuous improvement.

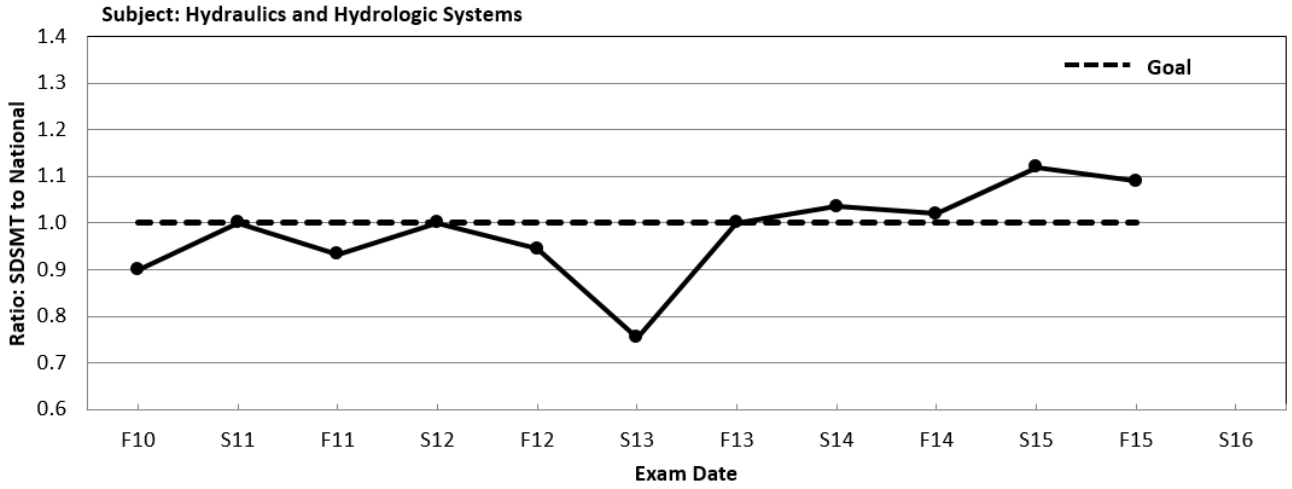
Table 4-40. Outcome (e) Summary 2011-2016

Student Outcome	2011-2012	2012 – 2013	2013 – 2014	2014 – 2015	2015 – 2016
(e)	67%	69%	94%	81%	81%
	80%-100% of students meet or exceed expectations				
	70%-80% of students meet or exceed expectations				
	60%-70% of students meet or exceed expectations				
	Less than 60% of students meet or exceed expectations				

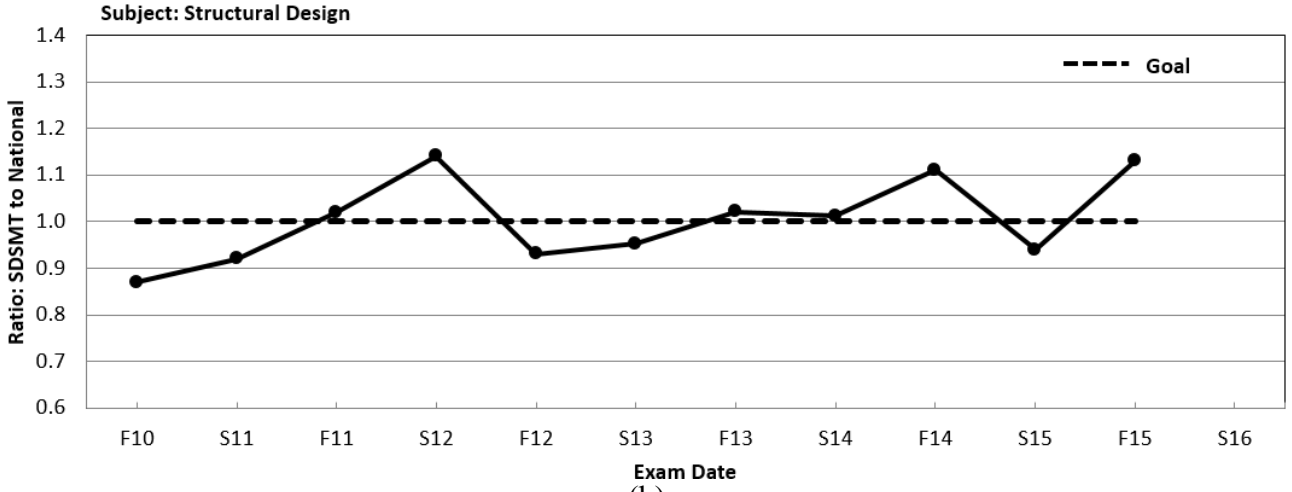
Table 4-41. FE Topics related to Outcome (e) 2010-2016

FE Topic	Outcome	Courses	10/11	11/12	12/13	13/14	14/15	F15
Hydraulics and Hydrologic Systems	(e)	CEE 336/337	0.97	0.97	0.86	1.01	1.09	1.09
Structural Design	(e)	CEE 453/456	0.90	1.08	0.94	1.02	1.00	1.13
Geotechnical Engineering	(e)	CEE 346/347 447/448	0.93	1.00	0.95	0.98	0.98	1.12
Transportation Engineering	(e)	CEE 468	0.95	0.97	0.85	1.04	0.94	1.02
Environmental Engineering	(e)	CEE 326/327	0.92	0.91	0.87	1.11	1.00	1.19
	Greater than 1.0							
	0.9 to 1.0							
	0.8 to 0.9							
	Less than 0.8							

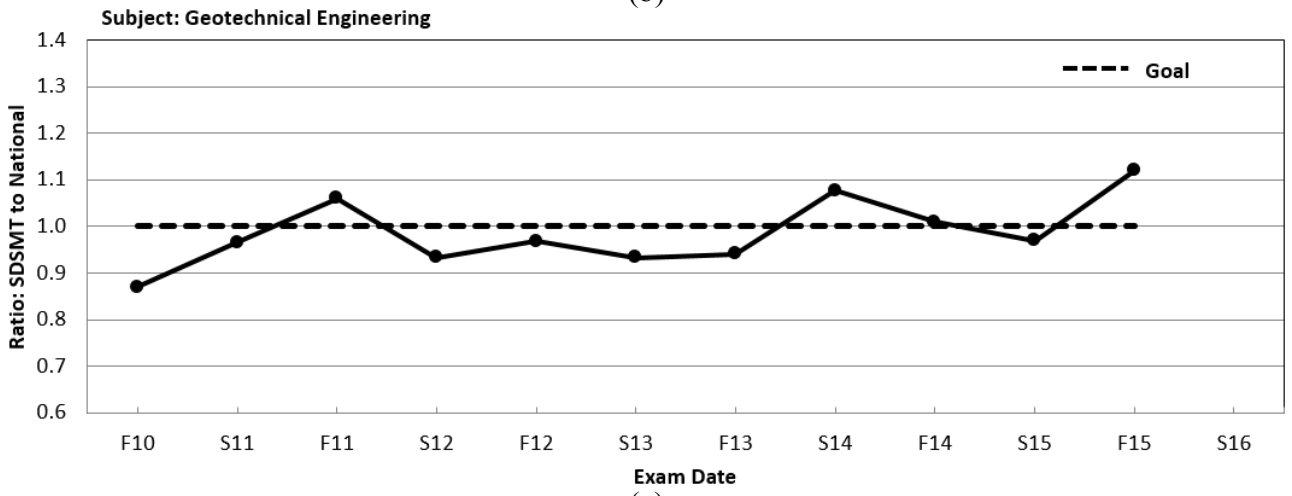
Outcome E



(a)

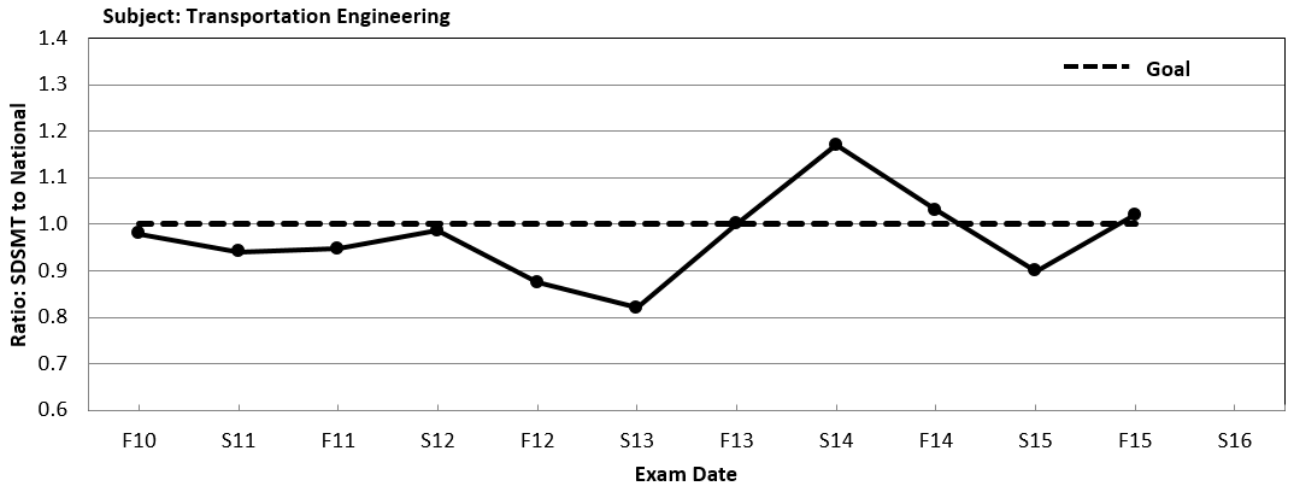


(b)

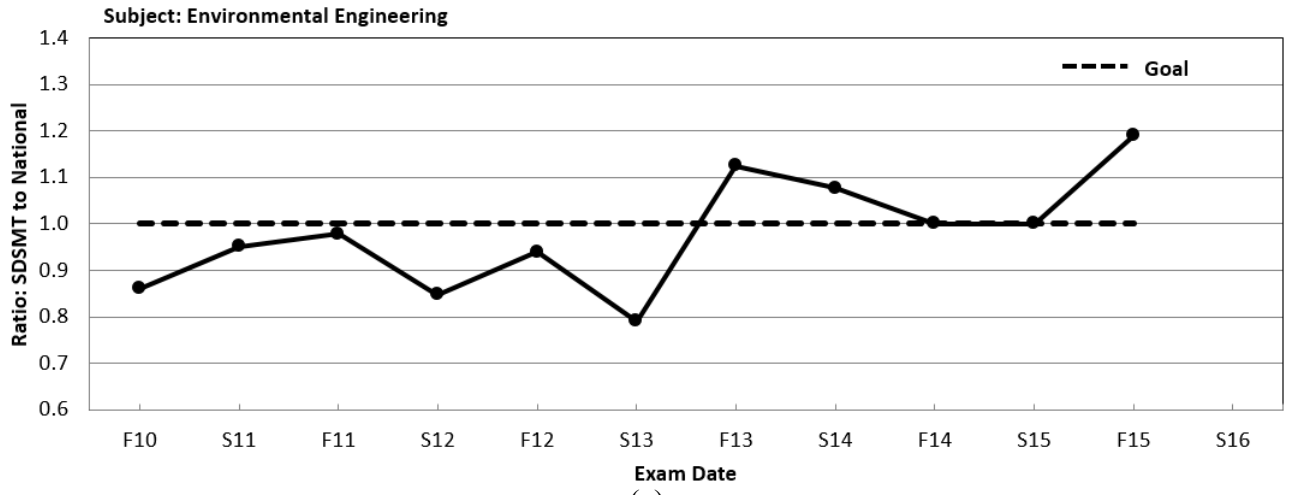


(c)

Outcome E



(d)



(e)

Figure 4-4-13. Plots of FE results for each semester from 2010-2016 for subjects (a) Hydraulics and Hydrologic Systems, (b) Structural Design, (c) Geotechnical Engineering, (d) Transportation Engineering, and (e) Environmental Engineering.

Outcome E

Intermediate Plan Results (2012-13 and 2013-14)

This section presents the results from the Intermediate Assessment plan (2012-2014). Data sources related to each performance indicator along with assessment instruments are provided in Table 4-42. A bar graph showing the percentage of students who met or exceeded expectations for each of the performance indicators is shown in Figure 4-14. A summary of the annual assessment results/observations as well as action items for continuous improvement are provided.

Table 4-42. Outcome (e) Data Sources 2012-2014

Performance Indicator	Rubric	Source: Instrument
1. Problem clarification	EDR 1	CEE 464: Project proposal
2. Engineering analysis and design	EDR 5	CEE 465: Progress report #2 & #3, final report

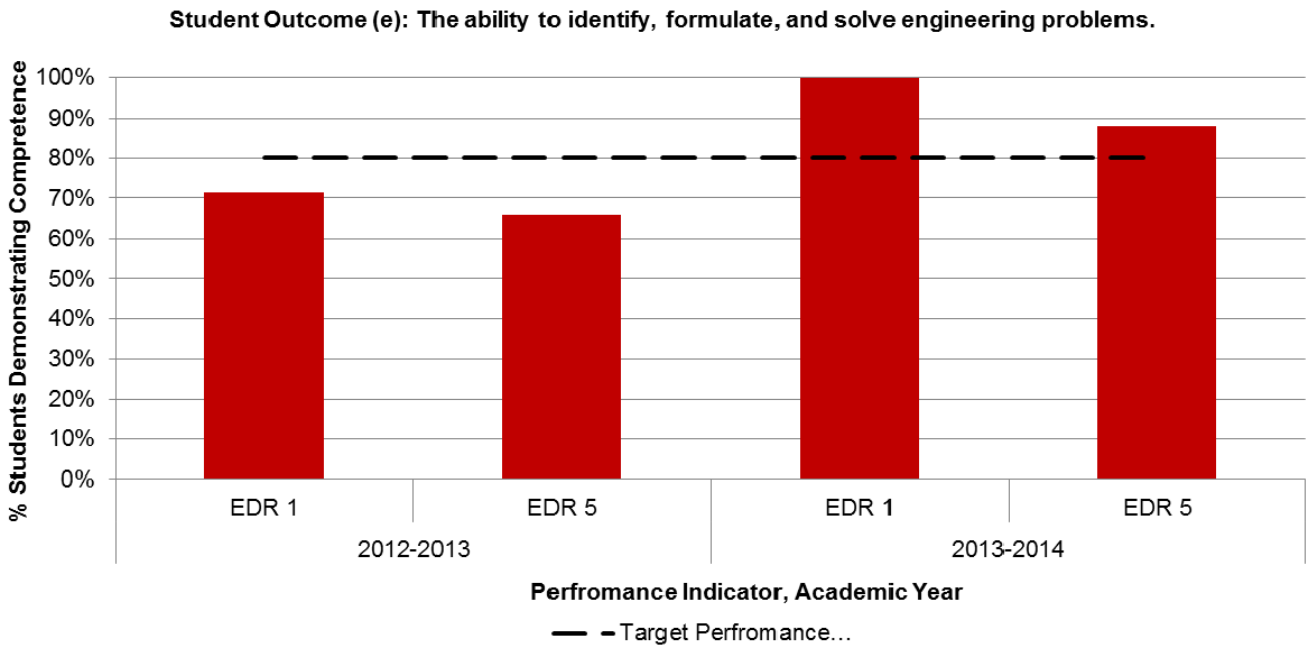


Figure 4-14. Student Outcome (e) results for 2012-2014.

Outcome E

Outcome E: Intermediate Assessment Plan Annual Evaluation Summary

Summary of Evaluation Process: Summative data for Student Outcome (e), the ability to identify, formulate, and solve engineering problems, is measured by four assessment instruments. The first assessment rubric, EDR 1, focuses on problem clarification which is defined as the student's ability to clearly articulate the problem after a thorough exploration of client and stakeholder raw data, fully maps these data to the design aspects of the project, clearly present target technical specifications, design methods and alternatives to be considered and completed. The student also clearly presents target technical specifications resulting from problem clarification. The students' ability in this area was measured in CEE 464 using the students' senior design project proposal. The second assessment rubric, EDR 5, focuses on engineering analysis and design which is defined by the student's ability to skillfully synthesize the results of modeling, simulation, and prototyping to refine the design and/or reformulate the problem. The students' ability in this area was measured in CEE 465 using the students' second and third progress report for their senior design project as well as their final report.

FE Exam: The Hydraulics/Hydrologic Systems, Soil Mechanics/Foundations, Structural Analysis, Environmental Engineering, and Construction Management exam topics on the FE Exam are contributing measurements of Student Outcome (e).

2012-13

Results/Observations: The capstone design course, CEE 464 & 465, was comprised of 35 students divided into eight teams. The performance of these 35 students (100% of the class) was assessed individually by the instructor, Dr. Damon Fick. 71% of the students met or exceeded expectations for Rubric 1 (EDR 1). 66% of the students were able to meet or exceed expectations for Rubric 2 (EDR 5). This was the initial use of these assessment rubrics. Student results of the two assessment rubrics fell below our target level of 80% of students meeting or exceeding the expectation of performance at the "competent" level or "3" on a scale of 0 – 5. We anticipate that increased exposure of both faculty and students to the engineering design assessment concepts and rubrics will improve results. Future measurements will be performed by faculty assessment teams who will undergo a calibration process to develop inter-rater reliability and increase the validity of the assessment. Of the four exam topics evaluated under Student Outcome (e), the target performance of 70% of questions answered correctly was met in one topic area, Construction Management (70% vs. 72%); however the target performance of meeting or exceeding the national average was not met.

Actions:

1) Performance indicators should be introduced in the context of the assessment rubrics (EDR 1 and 5) in supporting courses. Faculty will be trained on the use of the rubrics and underlying principles in the fall semester. Faculty will report on the results of their implementation at the end of the fall semester assessment meeting.
2) Ensure curriculum is aligned with FE content

2013-14

Results/Observations: Providing assessment rubrics to students resulted in a significant increase in the number of students meeting expectations. In order to get a better understanding of the curriculum as a whole it is recommended to go back to the previous assessment plan developed in 2010 in which assessments were conducted using courses from across the curriculum.

Actions:

1) Revert back to previous assessment plan.

Outcome E

Current Plan Results (2011-12, 2014-15, and 2015-16)

This section presents the results from the Current Assessment plan (2011 and 2014-2106). Data sources related to each performance indicator along with assessment instruments are provided in Table 4-43. The rubric used to evaluate each instrument in given in Table 4-44. A bar graph showing the percentage of students who met or exceeded expectations for each of the performance indicators is shown in Figure 4-15. A summary of the annual assessment results/observations as well as action items for continuous improvement are provided.

Table 4-43. Outcome (e) Data Sources 2011 and 2014-2016

Performance Indicator	Rubric	Source: Instrument
1. Identify relevant aspects of an engineering problem	Rubric (e)	CEE 346: Final Exam CEE 353: Select Exam Questions CEE 426: Homework: Design Problem CEE 456: Select Exam Questions
2. Solve formulated equations or systems of equations	Rubric (e)	CEE 346: Final Exam CEE 353: Select Exam Questions CEE 426: Homework: Design Problem CEE 456: Select Exam Questions

Table 4-44. Outcome E Assessment Rubric
e. An ability to identify, formulate, and solve engineering problems.

Performance Indicators	Below expectations 1 (50%-63%)	Minimally acceptable 2 (63%-75%)	Meets expectations 3 (75%-88%)	Exceeds expectations 4 (88%-100%)
1. Identify relevant aspects of an engineering problem	Problem poorly defined with inability to recognize relevant constraints, boundary or initial conditions	Problem defined with minimal ability to recognize relevant constraints, boundary and initial conditions	Problem defined with minimal errors in recognizing relevant constraints, boundary and initial conditions	Problem fully defined with relevant constraints, boundary and initial conditions
2. Solve formulated equations or systems of equations	Understanding of solution/numerical methods but lacking ability to apply to engineering problems	Understanding of solution/numerical methods with minimal ability to apply to engineering problems	Understanding of solution/numerical methods with ability to apply to engineering problems	Understanding of solution/numerical methods with ability to apply to engineering problems with minimal or no errors

Outcome E

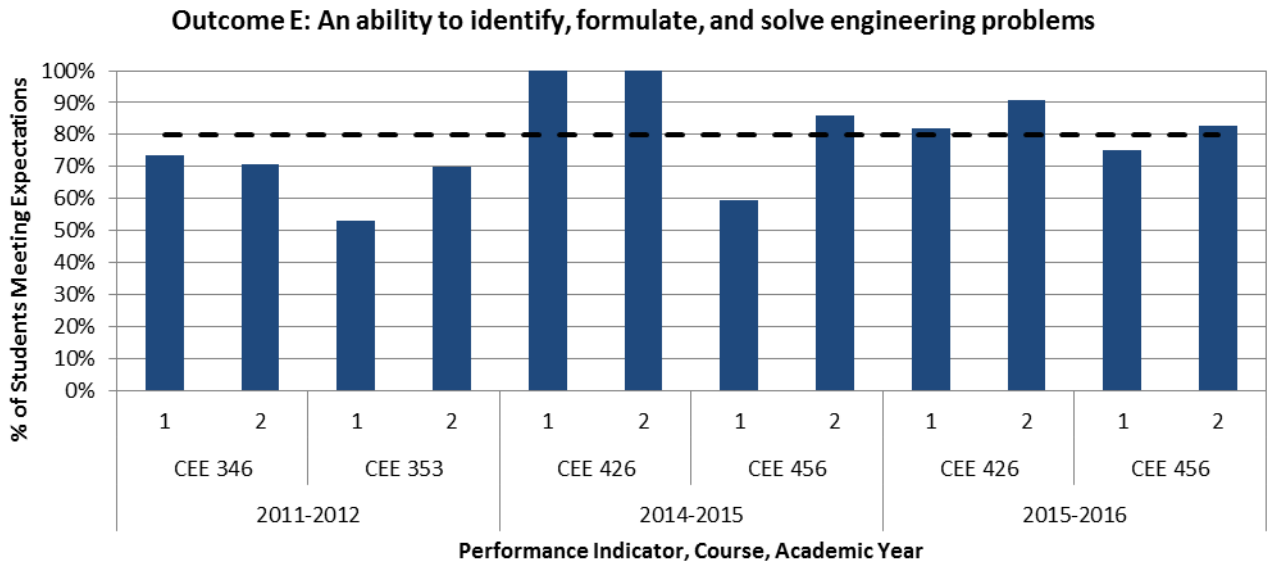


Figure 4-15. Student Outcome (e) results for 2011 and 2014-2016.

Outcome E

Outcome E: Current Assessment Plan Annual Evaluation Summary

Summary of Evaluation Process: Summative data for Student Outcome (e), an ability to identify, formulate, and solve engineering problems, is measured using rubric (e) developed by the faculty. The data was primarily obtained from exam questions and homework problems in CEE 456 and CEE 426. These problems/assignments were selected to allow the students to 1) identify relevant aspects of engineering problems, and 2) solve formulated equations or systems of equations. Students who scored 3 or higher (75%) based on rubric (e) were deemed to meet or exceed expectations. The department goal is to have 80% of the students meet or exceed expectations. In addition to course data, FE exam topics related to Outcome (e): Hydraulic and Hydrologic systems, Structural Design, Geotechnical Engineering, Transportations Engineering, and Environmental Engineering were used in the assessment. A summary of the previous actions, observations, and new action items recommended by the faculty during the annual assessment meetings are presented.

2014-15 (81% of students met expectations)

Previous Actions: None

Observations: Instructor had difficulty to assess performance indicator 1 in CEE 456.

New Actions:

1. Reinforce conceptualization of problems prior to solving.
2. Provide ample example problems.

2015-16 (81% of students met expectations)

Previous Actions (81% 2014-15):

1. Reinforce conceptualization of problems prior to solving.
2. Provide ample example problems.

Observations: FE exam scores are above the national average for design topics. Continue previous actions

New Actions: Continue previous actions incorporating examples and design projects. If anyone would like to use the design and construction of the new Alumni Center on campus Cliff Bienert can provide information.

Outcome F

An understanding of professional and ethical responsibility

A summary of the percentage of students meeting or exceeding expectations over the review period (2011-2016) is given in Table 4-45 followed by a summary of the FE exam results related to outcome (f) in Table 4-46 with plotted results provided in Figure 4-4-16**.** Subsequent sections present the assessment results from the intermediate assessment and the current assessment plans along with assessment results/observations and action plans for continuous improvement.

Table 4-45. Outcome (f) Summary 2011-2016

Student Outcome	2011-2012	2012 – 2013	2013 – 2014	2014 – 2015	2015 – 2016
(f)	64%	35%	76%	76%	95%

	80%-100% of students meet or exceed expectations
	70%-80% of students meet or exceed expectations
	60%-70% of students meet or exceed expectations
	Less than 60% of students meet or exceed expectations

Table 4-46. FE Topics related to Outcome (f) 2010-2016

FE Topic	Outcome	Courses	10/11	11/12	12/13	13/14	14/15	F15
Ethics and Professional Practice	(f)	CEE 463	1.03	1.01	1.01	1.07	0.98	1.07

	Greater than 1.0
	0.9 to 1.0
	0.8 to 0.9
	Less than 0.8

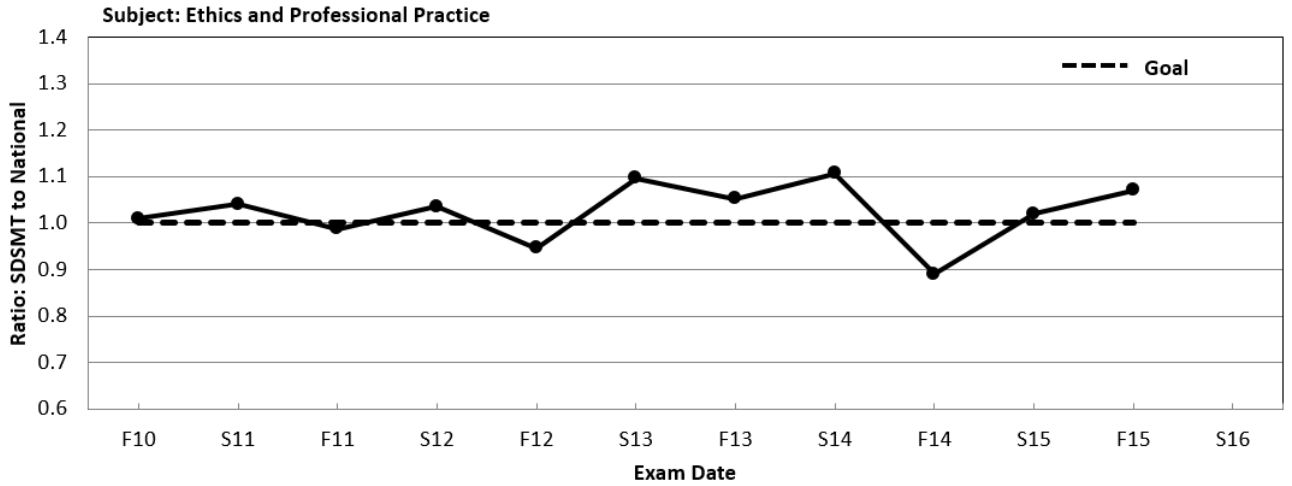


Figure 4-4-16. Plots of FE results for each semester from 2010-2016 for Ethics and Professional Practice.

Outcome F

Intermediate Plan Results (2012-13 and 2013-14)

This section presents the results from the Intermediate Assessment plan (2012-2014). Data sources related to each performance indicator along with assessment instruments are provided in Table 4-47. A bar graph showing the percentage of students who met or exceeded expectations for each of the performance indicators is shown in Figure 4-17. A summary of the annual assessment results/observations as well as action items for continuous improvement are provided.

Table 4-47. Outcome (f) Data Sources 2012-2014

Performance Indicator	Rubric	Source: Instrument
1. Impact analysis	EDR 3	CEE 465: Progress report #1
2. Final design results and recommendations	EDR 6	CEE 465: Progress report #3, final report
3. Recognize stakeholder perspectives, identify problems, identify ethical considerations	EPSA 1	CEE 463: EPSA discussion

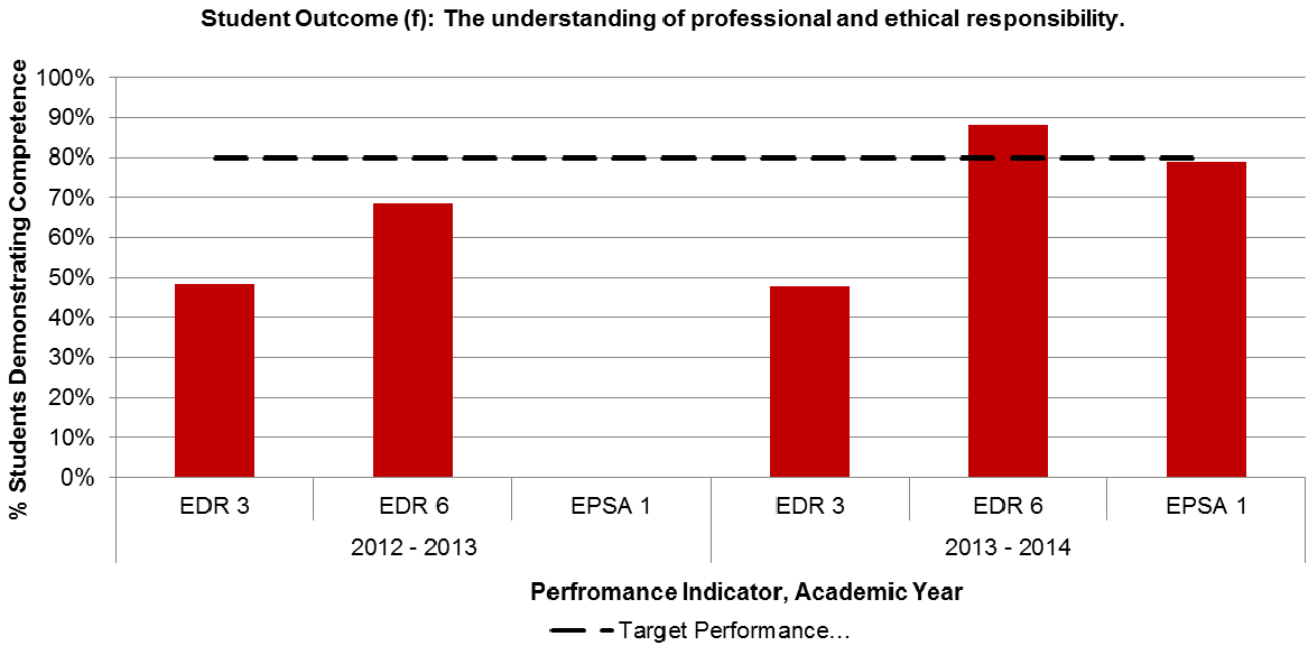


Figure 4-17. Student Outcome (f) results for 2012-2014.

Outcome F

Outcome F: Intermediate Assessment Plan Annual Evaluation Summary

Summary of Evaluation Process: Summative data for Student Outcome (f), the student's understanding of professional and ethical responsibility, is measured by four assessment instruments. The first assessment rubric, EDR 3, focuses on impact analysis which is defined as the student's consideration of the relevant impacts of the design in ethical, global, economic, societal, cultural, and environmental contexts. Students shall clearly show how relevant considerations have influenced target technical specifications and alternatives that were identified in the proposal. The students' ability in this area was measured in CEE 464 using the students' first progress report for their senior design project. The second assessment rubric, EDR 6, focuses on final design results and recommendations which are defined as the student's ability to presents clear and concise results of the analysis and design; and make insightful recommendations for future design work that identify lessons learned, limits, and constraints of the current project. The students' ability in this area was measured in CEE 465 using the students' third progress report for their senior design project as well as their final report. The third assessment rubric, EPSA 1, focuses on recognizing stakeholder perspectives, identifying problems, and identify ethical considerations which is defined as the student's ability to thoughtfully consider perspectives of all relevant stakeholders and articulate these with great clarity, accuracy, and empathy, the student's ability to convincingly frame the problem and parse it into sub-problems and suggest detailed and viable approaches to resolve the problems, and the student's ability to clearly articulate relevant ethical considerations and address these in discussing approaches to resolve the problems. The students' ability in this area was measured in CEE 463 using the students' EPSA discussion topic.

FE Exam: The Ethics and Business Practices and the Construction Management subject areas on the FE Exam are contributing measurements of Student Outcome (f).

2012-13

Results/Observations: The capstone design course, CEE 465, was comprised of 35 students divided into eight teams. The performance of these 35 students (100% of the class) was assessed individually by the instructor, Dr. Damon Fick. 49% of the students met or exceeded expectations for Rubric 1 (EDR 3). 69% of the students met or exceeded expectations for Rubric 2 (EDR 6). The CEE 463 course was comprised of a total of 23 students who were individually assessed by instructors Dr. Scott Amos and Dr. Marc Robinson. 0% of the students met or exceeded expectations for Rubric 3 (EPSA 1). This was the initial use of these assessment rubrics. Three of the five measured results (60%) from these assessment rubrics fell below our target level of 80% of students meeting or exceeding the expectation of performance at the "competent" level or "3" on a scale of 0 – 5. We anticipate that increased exposure of both faculty and students to the engineering design assessment concepts and rubrics will improve results. Future measurements will be performed by faculty assessment teams who will undergo a calibration process to develop inter-rater reliability and increase the validity of the assessment. Of the two FE Exam topics evaluated under Student Outcome (f), Construction Management (70% vs. 72%) and Ethics & Business Practices (79% vs. 82%), both topics met the target performance of 70% of questions answered correctly; however neither topic achieved the target performance of meeting or exceeding the national average

Actions:

1) Performance indicators should be introduced in the context of the assessment rubrics (EDR 3, 6 and EPSA 1) in supporting courses. Faculty will be trained on the use of the rubrics and underlying principles in the fall semester. Faculty will report on the results of their implementation at the end of the fall semester assessment meeting.
2) Ensure curriculum is aligned with FE content

2013-14

Results/Observations: Providing assessment rubrics to students resulted in a significant increase in the number of students meeting expectations. In order to get a better understanding of the curriculum as a whole it is recommended to go back to the original assessment plan developed in 2010 in which assessments were conducted using courses from across the curriculum.

Actions:

1) Revert back to previous assessment plan.

Outcome F

Current Plan Results (2011-12, 2014-15, and 2015-16)

This section presents the results from the Current Assessment plan (2011 and 2014-2106). Data sources related to each performance indicator along with assessment instruments are provided in Table 4-48. The rubric used to evaluate each instrument in given in Table 4-49. A bar graph showing the percentage of students who met or exceeded expectations for each of the performance indicators is shown in Figure 4-18. A summary of the annual assessment results/observations as well as action items for continuous improvement are provided.

Table 4-48. Outcome (f) Data Sources 2011 and 2014-2016

Performance Indicator	Rubric	Source: Instrument
1. Demonstrate understanding of the importance of and means to obtain professional registration	Rubric (f)	CEE 463: Student Survey CEE 474: Student Survey
2. Identify and apply ethical principles	Rubric (f)	CEE 463: Case Study Discussion CEE 474: Essay

Table 4-49. Outcome F Assessment Rubric

f. An understanding of professional and ethical responsibility.

Performance Indicators	Below expectations 1 (50%-63%)	Minimally acceptable 2 (63%-75%)	Meets expectations 3 (75%-88%)	Exceeds expectations 4 (88%-100%)
1. Demonstrate understanding of the importance of and means to obtain professional registration	Does not understand the importance of professional registration	Demonstrates understanding of the importance of professional registration	Prepares for and takes the FE exam prior to graduation	Passes the FE exam
2. Identify and apply ethical principles	Unaware of codes of conduct and their implications Unable to identify ethical issues	Is aware of the codes of conduct that guide the professional practice Identifies and defines ethical issues	Discusses the professional code of ethics applicable to his/her chosen field and /or applies appropriate ethical reasoning to problem/issue at hand	Applies relevant aspects of professional codes of ethics when considering possible alternatives decisions or solutions

Outcome F

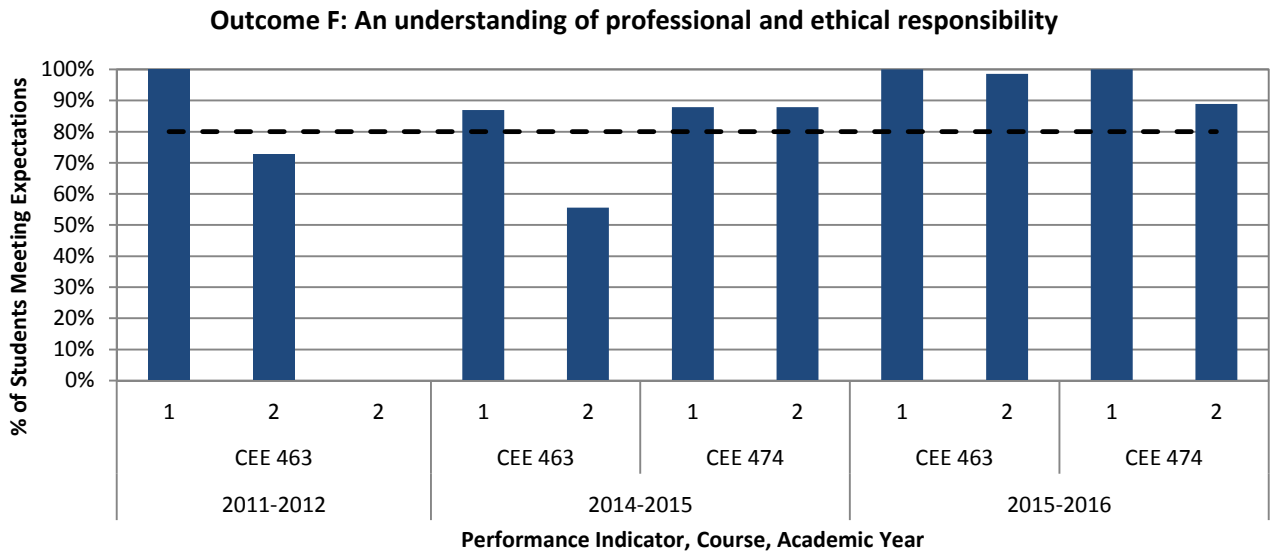


Figure 4-18. Student Outcome (f) results for 2011 and 2014-2016.

Outcome F

Outcome F: Current Assessment Plan Annual Evaluation Summary

Summary of Evaluation Process: Summative data for Student Outcome (f), an understanding of professional and ethical responsibility, is measured using rubric (f) developed by the faculty. The data was primarily obtained from student surveys, cases studies and essays in CEE 463 and CEE 474. These assignments were selected to allow the students to: 1) demonstrate understanding of the importance of and means to obtain professional registration, and 2) identify and apply ethical principles. Students who scored 3 or higher (75%) based on rubric (f) were deemed to meet or exceed expectations. The department goal is to have 80% of the students meet or exceed expectations. In addition to course data, FE exam topics related to Outcome (f): Ethics and Professional Practice. A summary of the previous actions, observations, and new action items recommended by the faculty during the annual assessment meetings are presented.

2014-15 (76% of students met expectations)

Previous Actions: None

Observations:
The department goal was not met. Students struggled with application of ethics. FE scores for the ethics topic have traditionally been above the national average. However this year they were slightly below.

New Actions:
1. Cliff will provide process for solving ethics problems to faculty. Include ethics issues in other courses.
2. Include ASCE code of ethics into CEE 474.
3. Emphasize importance of licensure in courses.
4. Collect examples of contemporary ethics issues.

2015-16 (95% of students met expectations)

Previous Actions:
1. Cliff will provide process for solving ethics problems to faculty. Include ethics issues in other courses.
2. Include ASCE code of ethics into CEE 474.
3. Emphasize importance of licensure in courses.
4. Collect examples of contemporary ethics issues.

Observations: The department goal was met. A high level of emphasis was put on ethics and the FE exam in CEE 463. Future coordination needs to occur between CEE 463 and CEE 474 as to which topics will be covered in each course. Based on a limited sample size of students FE scores exceed the national average for fall 2016.

New Actions:
Coordinate CE 463 and CEE 474 to address previous action items

Outcome G

An ability to communicate effectively

A summary of the percentage of students meeting or exceeding expectations over the review period (2011-2016) is given in Table 4-50**.** Subsequent sections present the assessment results from the intermediate assessment and the current assessment plans along with assessment results/observations and action plans for continuous improvement.

Table 4-50. Outcome (g) Summary 2011-2016

Student Outcome	2011-2012	2012 – 2013	2013 – 2014	2014 – 2015	2015 – 2016
(g)	---	77%	92%	100%	92%
	80%-100% of students meet or exceed expectations				
	70%-80% of students meet or exceed expectations				
	60%-70% of students meet or exceed expectations				
	Less than 60% of students meet or exceed expectations				

Outcome G

Intermediate Plan Results (2012-13 and 2013-14)

This section presents the results from the Intermediate Assessment plan (2012-2014). Data sources related to each performance indicator along with assessment instruments are provided in Table 4-51. A bar graph showing the percentage of students who met or exceeded expectations for each of the performance indicators is shown in Figure 4-19. A summary of the annual assessment results/observations as well as action items for continuous improvement are provided.

Table 4-51. Outcome (g) Data Sources 2012-2014

Performance Indicator	Rubric	Source: Instrument
1. Written communication	EDR 7a	CEE 465: Third progress report and final report
2. Oral communication	EDR 7b	CEE 465: Final poster and oral presentation
3. Group interaction, group self-regulation	EPSA 2	CEE 463: EPSA discussion

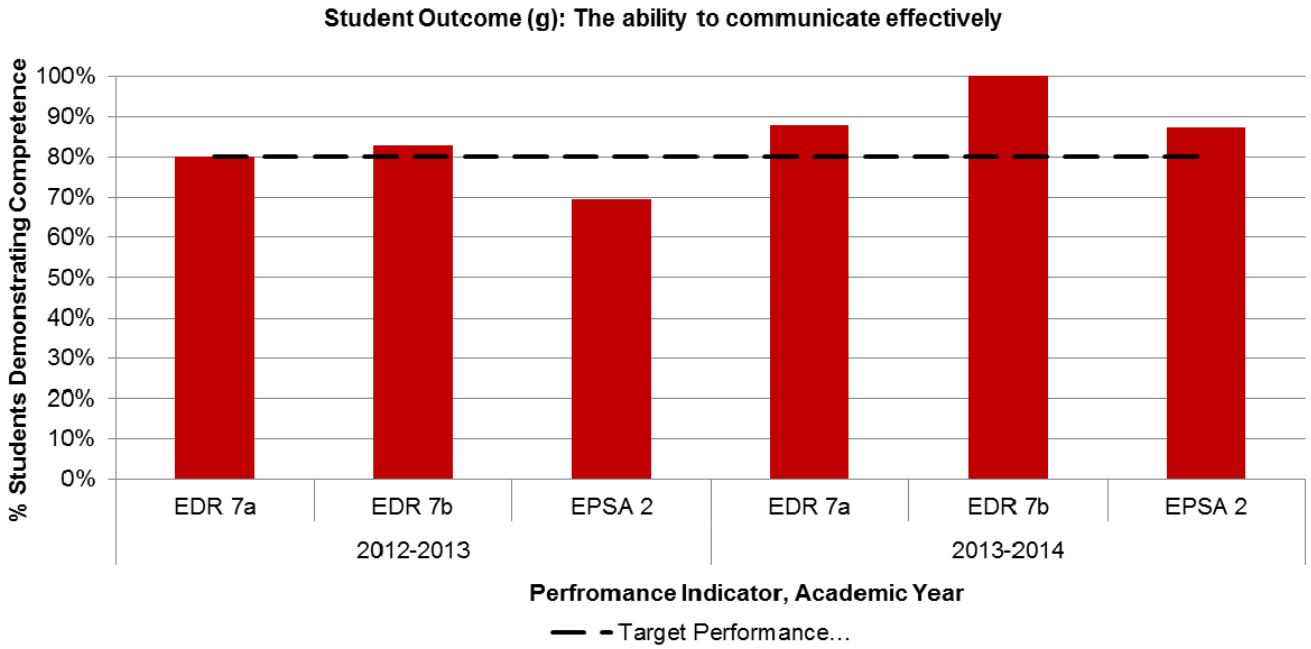


Figure 4-19. Student Outcome (g) results for 2012-2014.

Outcome G

Outcome G: Intermediate Assessment Plan Annual Evaluation Summary

Summary of Evaluation Process: Summative data for Student Outcome (g), the student's ability to communicate effectively, is measured by three assessment instruments. The first assessment rubric, EDR 7a, focuses on communication which is defined as the student's ability to communicate in an organized and professional manner with multiple audiences, including clients, stakeholders, other team members, and professional reviewers in the form of a written report. The students' ability in this area was measured in CEE 465 using the students' third progress report and the final report for their senior design project. The second assessment rubric, EDR 7b, focuses on communication which is defined as the student's ability to communicate in an organized and professional manner with multiple audiences, including clients, stakeholders, other team members, and professional reviewers in the form of visual aid and oral presentation. The students' ability in this area was measured in CEE 464/465 using the students' project proposal presentation and final poster and oral presentation for their senior design project. The third assessment rubric, EPSA 2, focuses on group interaction and group self-regulation which is defined as the student's ability to clearly encourage participation from all group members, generate ideas together and actively help each other clarify ideas as well as work together to reach a consensus in order to clearly frame the problems and develop appropriate, concrete ways to resolve the problems. The students' ability in this area was measured in CEE 463 using the students' EPSA discussion topic.

2012-13

Results/Observations: The capstone design course, CEE 465, was comprised of 35 students divided into eight teams. The performance of these 35 students (100% of the class) was assessed individually by the instructor, Dr. Damon Fick. 80% of the students met or exceeded expectations for Rubric 1 (EDR 7a). 83% of the students met or exceeded expectations for Rubric 2 (EDR 7b). The CEE 463 course was comprised of a total of 23 students who were individually assessed by instructors Dr. Scott Amos and Dr. Marc Robinson. 70% of the students met or exceeded expectations for Rubric 3 (EPSA 2). This was the initial deployment of these assessment rubrics. One of the three assessment rubrics fell below (33%) our target level of 80% of students meeting or exceeding the expectation of performance at the "competent" level or "3" on a scale of 0 – 5. We anticipate that increased exposure of both faculty and students to the engineering design assessment concepts and rubrics will improve results. Future measurements will be performed by faculty assessment teams who will undergo a calibration process to develop inter-rater reliability and increase the validity of the assessment.

Actions: Performance indicators should be introduced in the context of the assessment rubrics (EDR 7a, 7b and EPSA 2) in supporting courses. Faculty will be trained on the use of the rubrics and underlying principles in the fall semester. Faculty will report on the results of their implementation at the end of the fall semester assessment meeting.

2013-14

Results/Observations: Providing assessment rubrics to students resulted in a significant increase in the number of students meeting expectations. In order to get a better understanding of the curriculum as a whole it is recommended to go back to the original assessment plan developed in 2010 in which assessments were conducted using courses from across the curriculum.

Actions:

1) Revert back to previous assessment plan.

Outcome G

Current Plan Results (2011-12, 2014-15, and 2015-16)

This section presents the results from the Current Assessment plan (2011 and 2014-2106). Data sources related to each performance indicator along with assessment instruments are provided in Table 4-52. The rubric used to evaluate each instrument in given in Table 4-53. The rubric provides the student performance scores while EDR 7a and b (Table 4-13 and Table 4-14) are utilized to define the criteria. A bar graph showing the percentage of students who met or exceeded expectations for each of the performance indicators is shown in Figure 4-20. A summary of the annual assessment results/observations as well as action items for continuous improvement are provided.

Table 4-52. Outcome (g) Data Sources 2011 and 2014-2016

Performance Indicator	Rubric	Source: Instrument
1. Effectively communicate information, ideas, and findings in writing	Rubric (g)	CEE 463: Case Study Discussion CEE 489: Final Report (EDR 7b)
2. Effectively communicate information, ideas and findings orally	Rubric (g)	CEE 463: Case Study Discussion CEE 489: Final Report (EDR 7a)

Table 4-53. Outcome G Assessment Rubric

g. Ability to communicate effectively.

Performance Indicators	Below expectations 1 (50%-63%)	Minimally acceptable 2 (63%-75%)	Meets expectations 3 (75%-88%)	Exceeds expectations 4 (88%-100%)
1. Effectively communicate information, ideas, and findings in writing	EDR 7a	EDR 7a	EDR 7a	EDR 7a
2. Effectively communicate information, ideas and findings orally	EDR 7b	EDR 7b	EDR 7b	EDR 7b

Outcome G

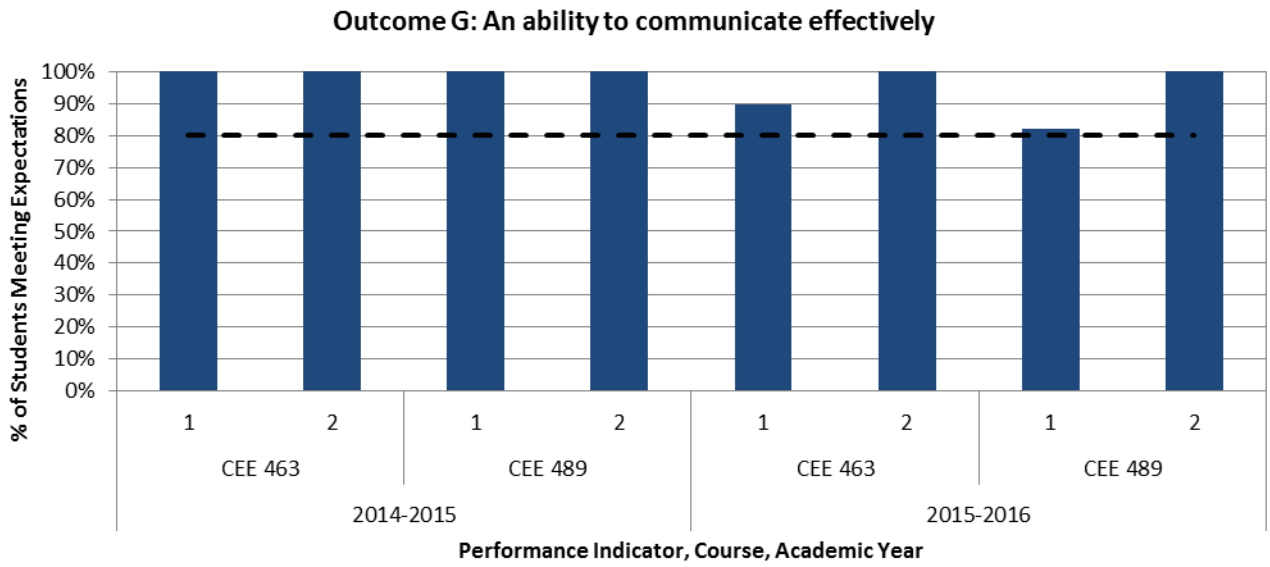


Figure 4-20. Student Outcome (g) results for 2011 and 2014-2016.

Outcome G

Outcome G: Current Assessment Plan Annual Evaluation Summary

Summary of Evaluation Process: Summative data for Student Outcome (g), an ability to communicate effectively, is measured using course specific rubrics. The data was primarily obtained from case study discussions and final reports from CEE 463 and CEE 489. These assignments were selected to allow the students to demonstrate their ability to 1) Effectively communicate information, ideas, and findings in writing, and 2) effectively communicate information, ideas, and findings orally. Students who scored 3 or higher (75%) based on rubrics were deemed to meet or exceed expectations. The department goal is to have 80% of the students meet or exceed expectations. A summary of the previous actions, observations, and new action items recommended by the faculty during the annual assessment meetings are presented.

2014-15 (100% of students met expectations)

Previous Actions:
Spring 2014 provided assessment rubrics to students in CEE 489.

Observations:
Students met expectations.
Individual assessment is difficult for team projects.
Consider other rubrics for assessing oral communication.
Journaling is a good tool for developing writing.
Practice presentations in CEE 489 (spring 2015) greatly enhanced the quality of final presentations

New Actions:
1. CEE 463 use individual writing assignments fall 2015.
2. Implement common rubrics for assessing written and oral communication.
3. Continue practice presentation sessions and poster preview.

2015-16 (92% of students met expectations)

Previous Actions (100% 2014-15):
1. CEE 463 use individual writing assignments fall 2015.
2. Implement common rubrics for assessing written and oral communication.
3. Continue practice presentation sessions with instructor feedback and poster preview.

Observations:
Students are meeting expectations. Practice presentations were implemented again in CEE 489. Capstone Design presentations were very good spring semester. From the Senior Exit Survey students felt that the junior year required too many lab reports which were redundant. Faculty discussed merits of continued lab reports.

New Actions:
1. Implement common rubrics for assessing written and oral communication (Robinson).
2. Provide a report outline for CEE 489 (Capstone Design). Dr. Robinson developed an outline spring 2016.

Outcome H

The broad education necessary to understand the impact of engineering solutions in a global and sustainable (economic, environmental, and societal) context

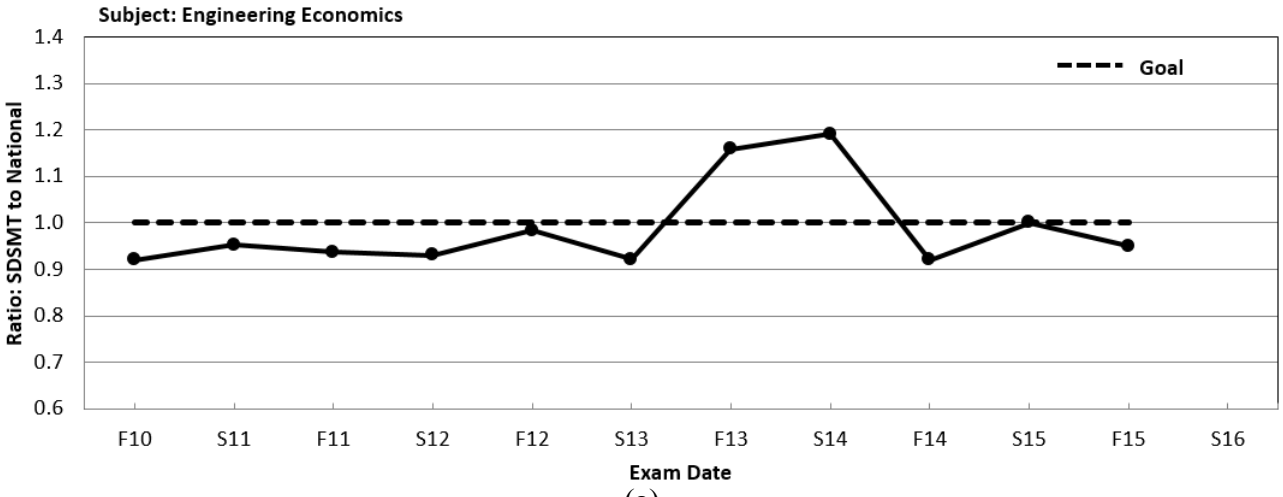
A summary of the percentage of students meeting or exceeding expectations over the review period (2011-2016) is given in Table 4-45 followed by a summary of the FE exam results related to outcome (f) in Table 4-46 with plotted results provided in Figure 4-4-16**.** Subsequent sections present the assessment results from the intermediate assessment and the current assessment plans along with assessment results/observations and action plans for continuous improvement.

Table 4-54. Outcome (h) Summary 2011-2016

Student Outcome	2011-2012	2012 – 2013	2013 – 2014	2014 – 2015	2015 – 2016
(h)	100%	37%	67%	68%	88%
	80%-100% of students meet or exceed expectations				
	70%-80% of students meet or exceed expectations				
	60%-70% of students meet or exceed expectations				
	Less than 60% of students meet or exceed expectations				

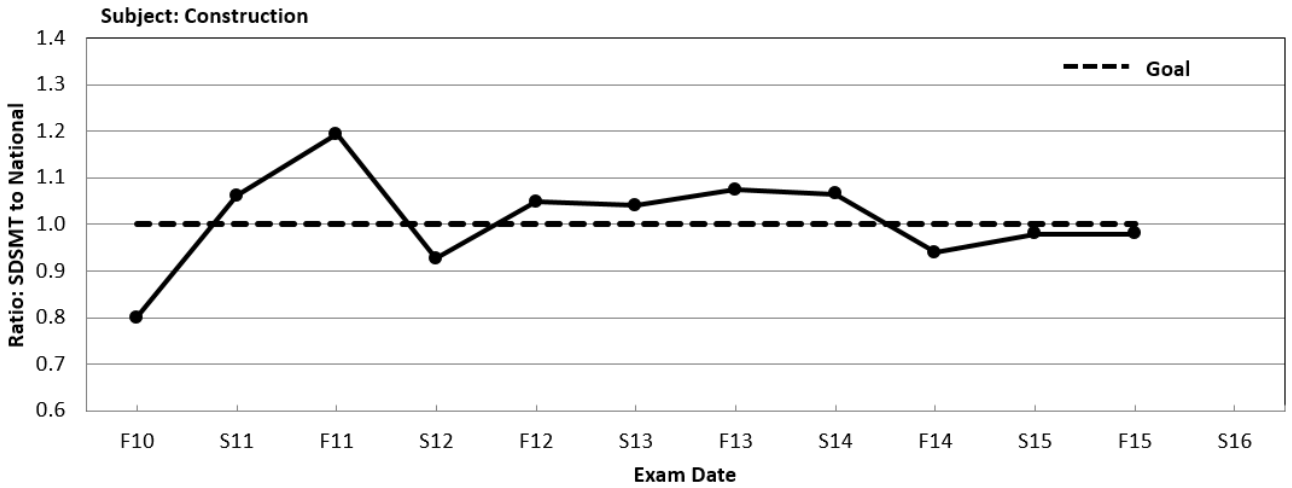
Table 4-55. FE Topics related to Outcome (h) 2010-2016

FE Topic	Outcome	Courses	10/11	11/12	12/13	13/14	14/15	F15
Engineering Economics	(h)	IENG 302	0.94	0.93	0.96	1.17	0.97	0.95
Construction	(h)	CEE 474	0.98	1.06	1.05	1.07	0.97	0.98
	Greater than 1.0							
	0.9 to 1.0							
	0.8 to 0.9							
	Less than 0.8							



(a)

Outcome H



(b)

Figure 4-21. Plots of FE results for each semester from 2010-2016 for subjects (a) Engineering Economics and, (b) Construction.

Outcome H

Intermediate Plan Results (2012-13 and 2013-14)

This section presents the results from the Intermediate Assessment plan (2012-2014). Data sources related to each performance indicator along with assessment instruments are provided in Table 4-56. A bar graph showing the percentage of students who met or exceeded expectations for each of the performance indicators is shown in Figure 4-22. A summary of the annual assessment results/observations as well as action items for continuous improvement are provided.

Table 4-56. Outcome (h) Data Sources 2012-2014

Performance Indicator	Rubric	Source: Instrument
1. Impact analysis	EDR 3	CEE 464: Progress report #1
2. Design development/concept generation	EDR 4	CEE 464/465: Progress report #1 & #2
3. Considers the impacts of solutions	EPSA 3	CEE 463: EPSA discussion

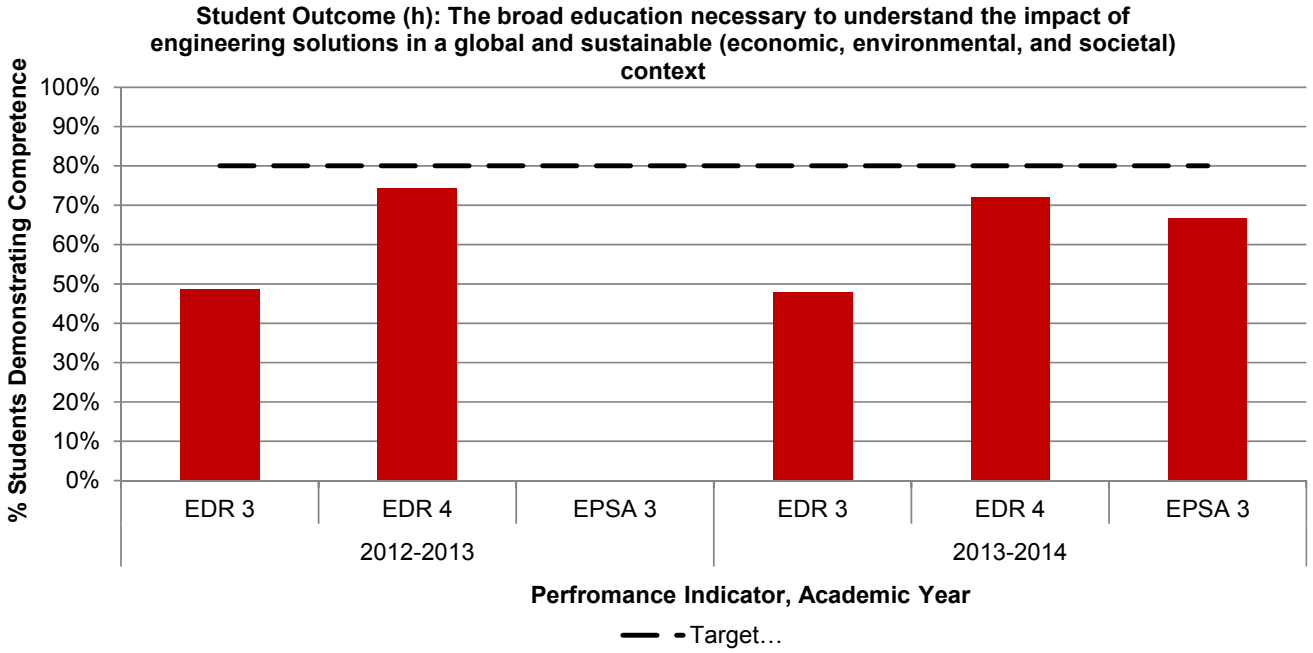


Figure 4-22. Student Outcome (h) results for 2012-2014.

Outcome H

Outcome H: Intermediate Assessment Plan Annual Evaluation Summary

Summary of Evaluation Process: Summative data for Student Outcome (h), the student's ability to understand the impact of engineering solutions in a global and sustainable (economic, environmental, and societal) context, is measured by four assessment instruments. The first assessment rubric, EDR 3, focuses on impact analysis which is defined as the student's consideration of the relevant impacts of the design in ethical, global, economic, societal, cultural, and environmental contexts. Students clearly show how relevant considerations have influenced target technical specifications and alternatives that were identified in the proposal. The students' ability in this area was measured in CEE 464 using the students' first progress report on their senior design project. The second assessment rubric, EDR 4, focuses on design development and concept selection which is defined as the student's ability to methodically narrow down design choices in ways that refine concepts and lead to focusing on the most promising design solutions that incorporate relevant considerations identified in the Impact Analysis. The students' ability in this area was measured in CEE 464/465 using the students' first and second progress reports for their senior design project. The third assessment rubric, EPSA 3, focuses on the consideration of impacts and solutions which is defined as the student's ability to clearly examine and weigh the impact of the ways to address the problem in all relevant contexts. The students' ability in this area was measured in CEE 463 using the students' EPSA discussion topic.

FE Exam: The Engineering Economics subject area on the FE Exam is a contributing measurement of Student Outcome (h).

2012-13

Results/Observations: The capstone design course, CEE 465, was comprised of 35 students divided into eight teams. The performance of these 35 students (100% of the class) was assessed individually by the instructor, Dr. Damon Fick. 49% of the students met or exceeded expectations for Rubric 1 (EDR 3). 74% of the students met or exceeded expectations for Rubric 2 (EDR 4). The CEE 463 course was comprised of a total of 23 students who were individually assessed by instructors Dr. Scott Amos and Dr. Marc Robinson. 0% of the students met or exceeded expectations for Rubric 3 (EPSA 3). This was the initial use of these assessment rubrics. Student results fell below our target level of 80% of students meeting or exceeding the expectation of performance at the "competent" level or "3" on a scale of 0 – 5. We anticipate that increased exposure of both faculty and students to the engineering design assessment concepts and rubrics will improve results. Future measurements will be performed by faculty assessment teams who will undergo a calibration process to develop inter-rater reliability and increase the validity of the assessment. In the subject area of Engineering Economics (61% vs. 64%) the target performance of 70% of questions answered correctly along with meeting or exceeding the national average was not met.

Actions: Performance indicators should be introduced in the context of the assessment rubrics (EDR 3, 4, and EPSA 3) in supporting courses. Faculty will be trained on the use of the rubrics and underlying principles in the fall semester. Faculty will report on the results of their implementation at the end of the fall semester assessment meeting.

2013-14

Results/Observations: Providing assessment rubrics to students resulted in a significant increase in the number of students meeting expectations. In order to get a better understanding of the curriculum as a whole it is recommended to go back to the previous assessment plan developed in 2010 in which assessments were conducted using courses from across the curriculum.

Actions:

1) Revert back to previous assessment plan.

Outcome H

Current Plan Results (2011-12, 2014-15, and 2015-16)

This section presents the results from the Current Assessment plan (2011 and 2014-2106). Data sources related to each performance indicator along with assessment instruments are provided in Table 4-57. The rubric used to evaluate each instrument in given in Table 4-58. A bar graph showing the percentage of students who met or exceeded expectations for each of the performance indicators is shown in Figure 4-23 A summary of the annual assessment results/observations as well as action items for continuous improvement are provided.

Table 4-57. Outcome (h) Data Sources 2011 and 2014-2016

Performance Indicator	Rubric	Source: Instrument
1. Identify pertinent economic, environmental, social, and global issues relating to designs and problems	Rubric (h)	CEE 464: CEE 325: Group Project CEE 326: Case Study Discussion
2. Develop an appropriate design approach that evaluates global, societal, environmental, and economic implications of design	Rubric (h)	CEE 464: CEE 325: Group Project CEE 326: Case Study Discussion

Table 4-58. Outcome H Assessment Rubric

h. The broad education necessary to understand the impact of engineering solutions in a global and sustainable (economic, environmental, and societal) context.

Performance Indicators	Below expectations 1 (50%-63%)	Minimally acceptable 2 (63%-75%)	Meets expectations 3 (75%-88%)	Exceeds expectations 4 (88%-100%)
1. Identify pertinent economic, environmental, social, and global issues relating to designs or problems;	Does not address sustainability or global implications	Lists several types of impacts an engineering solution might have	Discusses potential implications in a sustainable context but not global	Discusses potential implications in light of the triple bottom line and within a global context
2. Develop an appropriate design approach that evaluates global, societal, environmental, and economic implications of design	Solution(s) is not feasible	Solution(s) is technically feasible, but no additional concerns are considered	Solution(s) considers implementation concerns and economic impact	Solution(s) considers implementation concerns, level of actual improvement, economic impact and shows an intrinsic motivation to understand and deal with global and social impacts and environmental life-cycle impacts

Outcome H

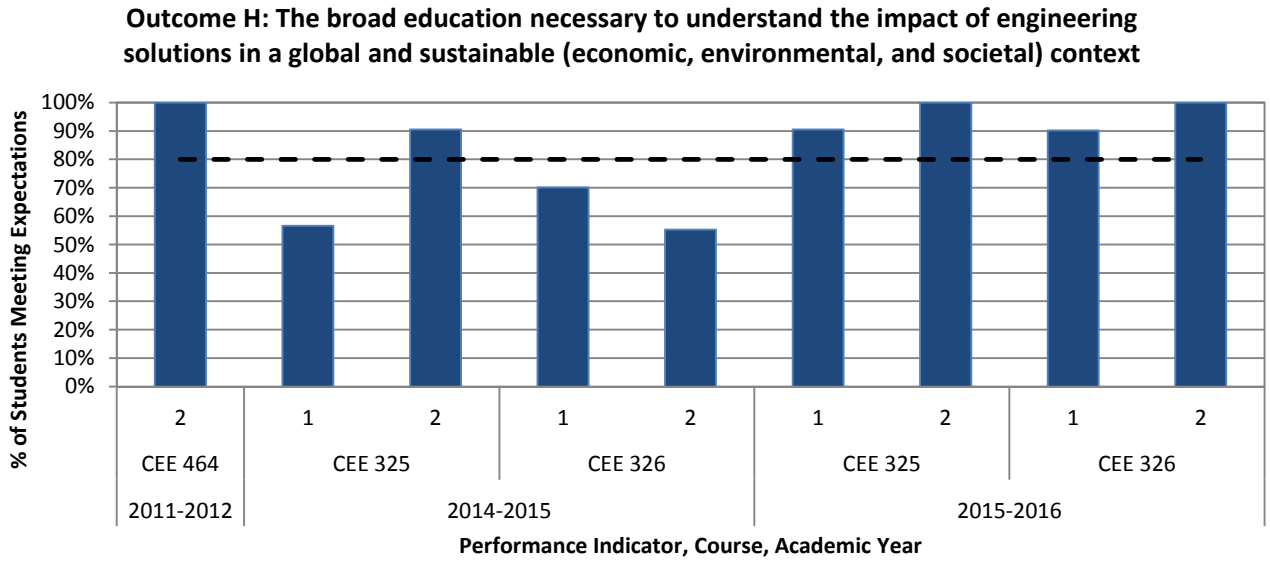


Figure 4-23. Student Outcome (h) results for 2011 and 2014-2016.

Outcome H

Outcome H: Current Assessment Plan Annual Evaluation Summary

Summary of Evaluation Process: Summative data for Student Outcome (h), the broad education necessary to understand the impact of engineering solutions in a global and sustainable (economic, environmental, and societal) context, is measured using rubric (h) developed by the faculty. The data was primarily obtained from projects and case studies in CEE 325 and CEE 326. These assignments were selected to allow the students to demonstrate their ability to 1) identify pertinent economic, environmental, social, and global issues relating to designs and problems, and 2) develop an appropriate design approach that evaluates global, societal, environmental, and economic implications of design. Students who scored 3 or higher (75%) based on rubric (h) were deemed to meet or exceed expectations. The department goal is to have 80% of the students meet or exceed expectations. In addition to course data, FE exam topics related to Outcome (h): Engineering Economics and Construction were used in the assessment. A summary of the previous actions, observations, and new action items recommended by the faculty during the annual assessment meetings are presented.

2014-15 (68% of students met expectations)

Previous Actions: None

Observations:
This outcome is difficult to measure since it is difficult to measure a student's understanding. In related FE topics students scored slightly below the national average.

New Actions:
Molly to follow up at Heads meeting how this is being measured at other universities.

2015-16 (95% of students met expectations)

Previous Actions:
Molly to follow up at Heads meeting how this is being measured at other universities.

Observations:
Department goal was met. Molly left the department before following up at the Heads meeting. Scott to follow up at Heads meeting how this is being measured at other universities. In related FE topics students scored slightly below the national average.

New Actions:
Scott Kenner to follow up at Heads meeting how this is being measured at other universities.

Outcome I

A recognition of the need for, and ability to engage in life-long learning

A summary of the percentage of students meeting or exceeding expectations over the review period (2011-2016) is given in Table 4-59**.** Subsequent sections present the assessment results from the intermediate assessment and the current assessment plans along with assessment results/observations and action plans for continuous improvement.

Table 4-59. Outcome (i) Summary 2011-2016

Student Outcome	2011-2012	2012 – 2013	2013 – 2014	2014 – 2015	2015 – 2016
(i)	---	35%	78%	70%	88%
	80%-100% of students meet or exceed expectations				
	70%-80% of students meet or exceed expectations				
	60%-70% of students meet or exceed expectations				
	Less than 60% of students meet or exceed expectations				

Outcome I

Intermediate Plan Results (2012-13 and 2013-14)

This section presents the results from the Intermediate Assessment plan (2012-2014). Data sources related to each performance indicator along with assessment instruments are provided in Table 4-60. A bar graph showing the percentage of students who met or exceeded expectations for each of the performance indicators is shown in Figure 4-24. A summary of the annual assessment results/observations as well as action items for continuous improvement are provided.

Table 4-60. Outcome (i) Data Sources 2012-2014

Performance Indicator	Rubric	Source: Instrument
1. Design development/concept generation	EDR 2	CEE 465: Project proposal
2. Impact analysis	EDR 3	CEE 465: Progress report #1
3. Final design results and recommendations	EDR 6	CEE 465: Third progress report, final report
4. Question sources and references, discern fact from opinion, differentiate between what they know and don't know, recognize their own presumptions	EPSA 4	CEE 463: EPSA discussion

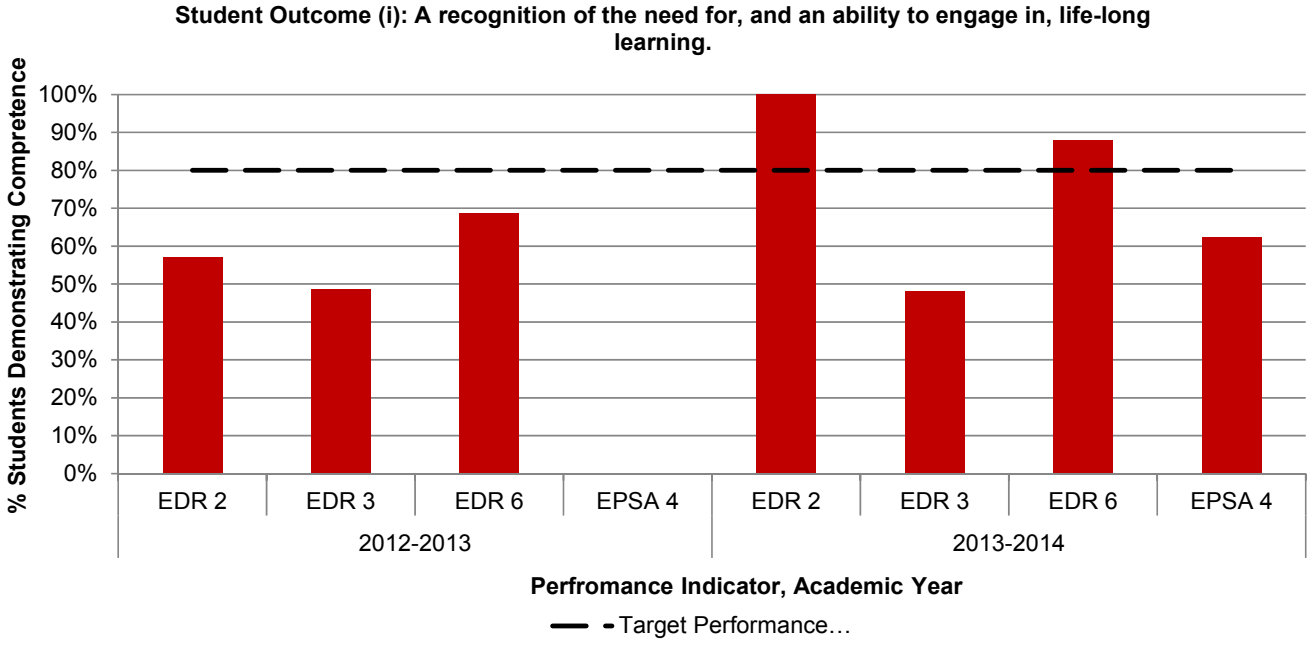


Figure 4-24. Student Outcome (i) results for 2012-2014.

Outcome I

Outcome I: Intermediate Assessment Plan Annual Evaluation Summary

Summary of Evaluation Process: Summative data for Student Outcome (i), the student's recognition of the need for, and ability to engage in life-long learning, is measured by four assessment instruments. The first assessment rubric, EDR 2, focuses on design development and concept generation which is defined as the student's ability to use multiple strategies, approaches, and materials, to generate a variety of ideas and alternatives to systematically explore possible solution paths. The students' ability in this area was measured in CEE 464 using the students' project proposal of their senior design project. The second assessment rubric, EDR 3, focuses on impact analysis which is defined as the student's consideration of the relevant impacts of the design in ethical, global, economic, societal, cultural, and environmental contexts. Students clearly show how relevant considerations have influenced target technical specifications and alternatives that were identified in the proposal. The students' ability in this area was measured in CEE 464 using the students' first progress report for their senior design project. The third assessment rubric, EDR 6, focuses on final design results and recommendations which are defined as the student's ability to present clear and concise results of the analysis and design. Insightful recommendations for future design work that identify lessons learned, limits, and constraints of the current project. The students' ability in this area was measured in CEE 465 using the students' third progress report and final report for their senior design project. The fourth assessment rubric, EPSA 4, focuses on questioning sources and references, discerning fact from opinion, differentiating between what is known and not known, and recognizing one's own presumptions which are defined as the student's ability to evaluate sources and references cited in the scenario, distinguishes fact from opinion expressed in the scenario, identifies what is still needed to be researched and describes the methods in which they intend to obtain their information and takes action to address their own presumptions that may hinder their problem solving abilities. The students' ability in this area was measured in CEE 463 using the students' EPSA discussion topic.

2012-13

Results/Observations: The capstone design course, CEE 465, was comprised of 35 students divided into eight teams. The performance of these 35 students (100% of the class) was assessed individually by the instructor, Dr. Damon Fick. 57% of the students met or exceeded expectations for Rubric 1 (EDR 2). 49% of the students met or exceeded expectations for Rubric 2 (EDR 3). 69% of the students met or exceeded expectations for Rubric 3 (EDR 6). The CEE 463 course was comprised of a total of 23 students who were individually assessed by instructors Dr. Scott Amos and Dr. Marc Robinson. 0% of the students met or exceeded expectations for Rubric 4 (EPSA 4). This was the initial use of these assessment rubrics. Student results fell below our target level of 80% of students meeting or exceeding the expectation of performance at the "competent" level or "3" on a scale of 0 – 5. We anticipate that increased exposure of both faculty and students to the engineering design assessment concepts and rubrics will improve results. Future measurements will be performed by faculty assessment teams who will undergo a calibration process to develop inter-rater reliability and increase the validity of the assessment.

Actions: Performance indicators should be introduced in the context of the assessment rubrics (EDR 2, 3, 6, and EPSA 4) in supporting courses. Faculty will be trained on the use of the rubrics and underlying principles in the fall semester. Faculty will report on the results of their implementation at the end of the fall semester assessment meeting.

2013-14

Results/Observations: Providing assessment rubrics to students resulted in a significant increase in the number of students meeting expectations. In order to get a better understanding of the curriculum as a whole it is recommended to go back to the previous assessment plan developed in 2010 in which assessments were conducted using courses from across the curriculum.

Actions:

1) Revert back to previous assessment plan.

Outcome I

Current Plan Results (2011-12, 2014-15, and 2015-16)

This section presents the results from the Current Assessment plan (2011 and 2014-2106). Data sources related to each performance indicator along with assessment instruments are provided in Table 4-61. The rubric used to evaluate each instrument in given in Table 4-62. A bar graph showing the percentage of students who met or exceeded expectations for each of the performance indicators is shown in Figure 4-25. A summary of the annual assessment results/observations as well as action items for continuous improvement are provided.

Table 4-61. Outcome (i) Data Sources 2011 and 2014-2016

Performance Indicator	Rubric	Source: Instrument
1. Demonstrate intention to continue education via graduate school or other means	Rubric (i)	CEE 463: Essay CEE 474: Student Survey
2. Identify the means by which life-long education can be pursued	Rubric (i)	CEE 463: Essay CEE 474: Essay

Table 4-62. Outcome I Assessment Rubric

i. A recognition of the need for, and ability to engage in life-long learning.

Performance Indicators	Below expectations 1 (50%-63%)	Minimally acceptable 2 (63%-75%)	Meets expectations 3 (75%-88%)	Exceeds expectations 4 (88%-100%)
1. Demonstrate intention to continue education via graduate school or other means	No plans for further study of any kind	Considering graduate studies or other continuing education	Plans for graduate studies or other continuing education	Has applied for graduate program or other advanced studies
2. Identify the means by which life-long education can be pursued	No ideas presented	Lists one opportunity for life-long learning	Lists some opportunities for life-long learning	Provides an extensive list of opportunities for life-long learning

Outcome I

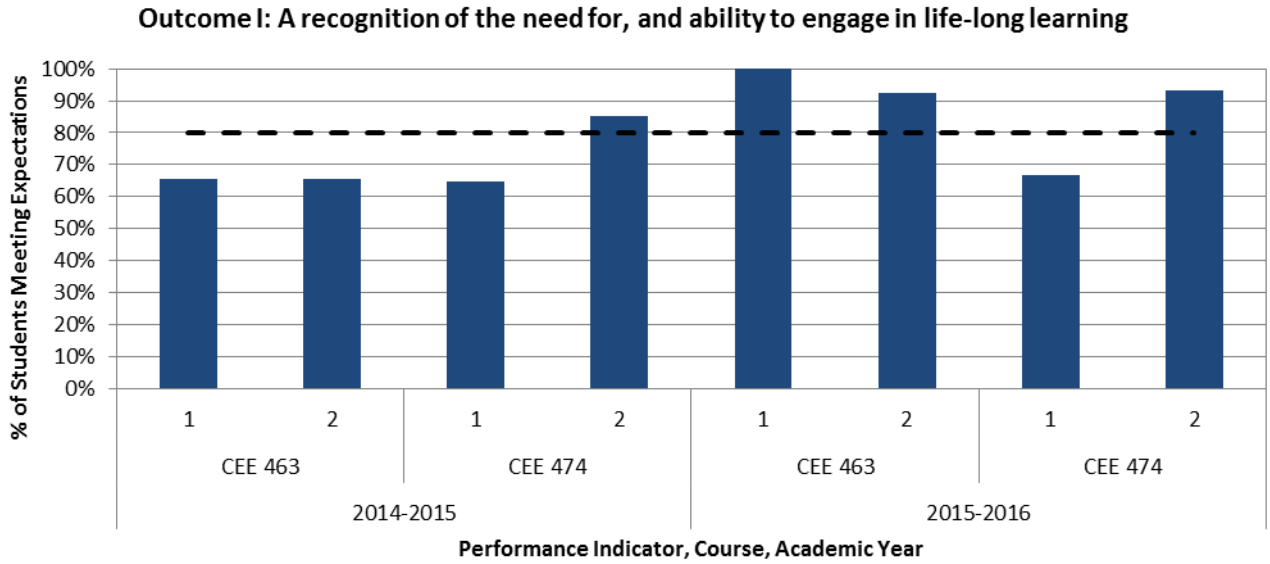


Figure 4-25. Student Outcome (i) results for 2011 and 2014-2016.

Outcome I

Outcome I: Current Assessment Plan Annual Evaluation Summary

Summary of Evaluation Process: Summative data for Student Outcome (i), a recognition of the need for, and ability to engage in life-long learning, is measured using rubric (i) developed by the faculty. The data was primarily obtained from essays and student surveys in CEE 463 and CEE 474. These assignments were selected to allow the students to 1) demonstrate their intention to continue education via graduate school of other means and 2) identify means by which life-long education can be pursued. Students who scored 3 or higher (75%) based on rubric (i) were deemed to meet or exceed expectations. The department goal is to have 80% of the students meet or exceed expectations. A summary of the previous actions, observations, and new action items recommended by the faculty during the annual assessment meetings are presented.

2014-15 (70% of students met expectations)

Previous Actions:
None

Observations:
Department goal was not achieved. Difficult to measure other means of continuing education. Consider changing indicators fall 2016.

New Actions:
Integrate into more discussions. Emphasize in courses that codes and design methods are always changing.

2015-16 (88% of students met expectations)

Previous Actions:
Integrate the need for life-long learning into more discussions. Emphasize in courses that codes and design methods are always changing.

Observations:
Department goal was achieved. Difficult to measure other means of continuing education. Consider changing indicators fall 2016.

New Actions:
1. Continue emphasizing the need for lifelong learning
2. Consider new performance indicators.

Outcome J

A knowledge of contemporary issues

A summary of the percentage of students meeting or exceeding expectations over the review period (2011-2016) is given in Table 4-63**.** Subsequent sections present the assessment results from the intermediate assessment and the current assessment plans along with assessment results/observations and action plans for continuous improvement.

Table 4-63. Outcome (j) Summary 2011-2016

Student Outcome	2011-2012	2012 – 2013	2013 – 2014	2014 – 2015	2015 – 2016
(j)	93%	43%	83%	82%	88%
	80%-100% of students meet or exceed expectations				
	70%-80% of students meet or exceed expectations				
	60%-70% of students meet or exceed expectations				
	Less than 60% of students meet or exceed expectations				

Outcome J

Intermediate Plan Results (2012-13 and 2013-14)

This section presents the results from the Intermediate Assessment plan (2012-2014). Data sources related to each performance indicator along with assessment instruments are provided in Table 4-64. A bar graph showing the percentage of students who met or exceeded expectations for each of the performance indicators is shown in Figure 4-26. A summary of the annual assessment results/observations as well as action items for continuous improvement are provided.

Table 4-64. Outcome (j) Data Sources 2012-2014

Performance Indicator	Rubric	Source: Instrument
1. Problem clarification	EDR 1	CEE 464: Project proposal
2. Impact analysis	EDR 3	CEE 465: Progress report #1
3. Final design results and recommendations	EDR 6	CEE 465: Third progress report, final report
4. Consider non-technical issues, display awareness of relevant technical issues/methods/tools surrounding the problem(s)	EPSA 5	CEE 463: EPSA discussion

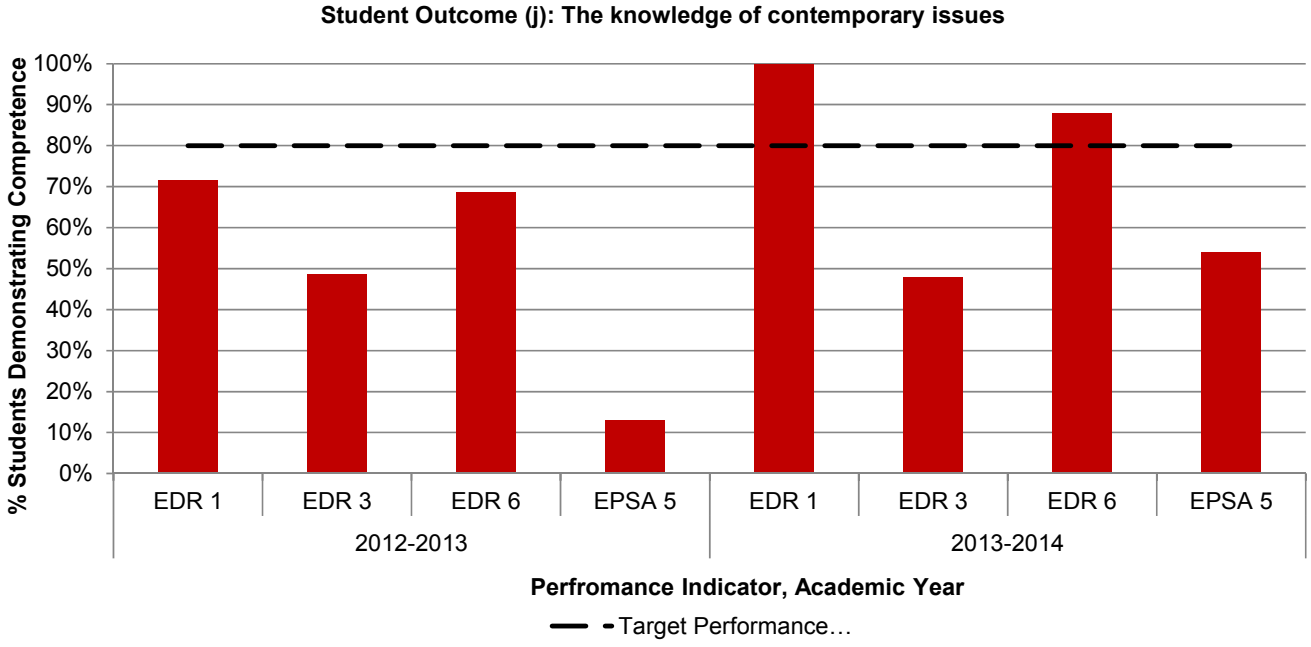


Figure 4-26. Student Outcome (j) results for 2012-2014.

Outcome J

Outcome J: Intermediate Assessment Plan Annual Evaluation Summary

Summary of Evaluation Process: Summative data for Student Outcome (j), the student's ability to demonstrate knowledge of contemporary issues, is measured by four assessment instruments. The first assessment rubric, EDR 1, focuses on problem clarification which is defined as the student's ability to clearly articulate the problem after a thorough exploration of client and stakeholder raw data and fully maps these data to the design aspects of the project. The student also clearly presents target technical specifications resulting from problem clarification. The students' ability in this area was measured in CEE 464 using the students' senior design project proposal. The second assessment rubric, EDR 3, focuses on impact analysis which is defined as the student's consideration of the relevant impacts of the design in ethical, global, economic, societal, cultural, and environmental contexts. Students clearly shows how relevant considerations have influenced target technical specifications and alternatives that were identified in the proposal. The students' ability in this area was measured in CEE 464 using the students' first progress report for their senior design project. The third assessment rubric, EDR 6, focuses on final design results and recommendations which are defined as the student's ability to present clear and concise results of the analysis and design. Insightful recommendations for future design work that identify lessons learned, limits, and constraints of the current project. The students' ability in this area was measured in CEE 465 using the students' third progress report and final report for their senior design project. The fourth assessment rubric, EPSA 5, focuses on the consideration of non-technical issues and the awareness of relevant technical issues, methods, and tools surrounding the problems which are defined as the student's ability to give full considerations to current societal, economic, and/or political issues along with modern methods, technologies and/or tools. The students' ability in this area was measured in CEE 463 using the students' EPSA discussion topic.

2012-13

Results/Observatins: The capstone design course, CEE 464 & 465, was comprised of 35 students divided into eight teams. The performance of these 35 students (100% of the class) was assessed individually by the instructor, Dr. Damon Fick. 71% of the students met or exceeded expectations for Rubric 1 (EDR 1). 49% of the students met or exceeded expectations for Rubric 2 (EDR 3). 69% of the students met or exceeded expectations for Rubric 3 (EDR 6). The CEE 463 course was comprised of a total of 23 students who were individually assessed by instructors Dr. Scott Amos and Dr. Marc Robinson. 13% of the students met or exceeded expectations for Rubric 4 (EPSA 5). This was the initial deployment of these assessment rubrics. Student results fell below of our target level of 80% of students meeting or exceeding the expectation of performance at the "competent" level or "3" on a scale of 0 – 5. We anticipate that increased exposure of both faculty and students to the engineering design assessment concepts and rubrics will improve results. Future measurements will be performed by faculty assessment teams who will undergo a calibration process to develop inter-rater reliability and increase the validity of the assessment.

Actions: Performance indicators should be introduced in the context of the assessment rubrics (EDR 1, 3, 6, and EPSA 5) in supporting courses. Faculty will be trained on the use of the rubrics and underlying principles in the fall semester. Faculty will report on the results of their implementation at the end of the fall semester assessment meeting.

2013-14

Results/Observations: Providing assessment rubrics to students resulted in a significant increase in the number of students meeting expectations. In order to get a better understanding of the curriculum as a whole it is recommended to go back to the previous assessment plan developed in 2010 in which assessments were conducted using courses from across the curriculum.

Actions:

1) Revert back to previous assessment plan.

Outcome J

Current Plan Results (2011-12, 2014-15, and 2015-16)

This section presents the results from the Current Assessment plan (2011 and 2014-2106). Data sources related to each performance indicator along with assessment instruments are provided in Table 4-65. The rubric used to evaluate each instrument in given in Table 4-66. A bar graph showing the percentage of students who met or exceeded expectations for each of the performance indicators is shown in Figure 4-27. A summary of the annual assessment results/observations as well as action items for continuous improvement are provided.

Table 4-65. Outcome (j) Data Sources 2011 and 2014-2016

Performance Indicator	Rubric	Source: Instrument
1. Identify contemporary issues that impact a given problem or design	Rubric (j)	CEE 326: Case Study Discussion CEE 474: Essay

Table 4-66. Outcome J Assessment Rubric

j. A knowledge of contemporary issues.

Performance Indicators	Below expectations 1 (50%-63%)	Minimally acceptable 2 (63%-75%)	Meets expectations 3 (75%-88%)	Exceeds expectations 4 (88%-100%)
1. Identify contemporary issues that impacts a given problem or design	Minimal or no characterization of contemporary issues	Partial characterization of contemporary issues	Substantial characterization of contemporary issues	Contemporary issues fully characterized

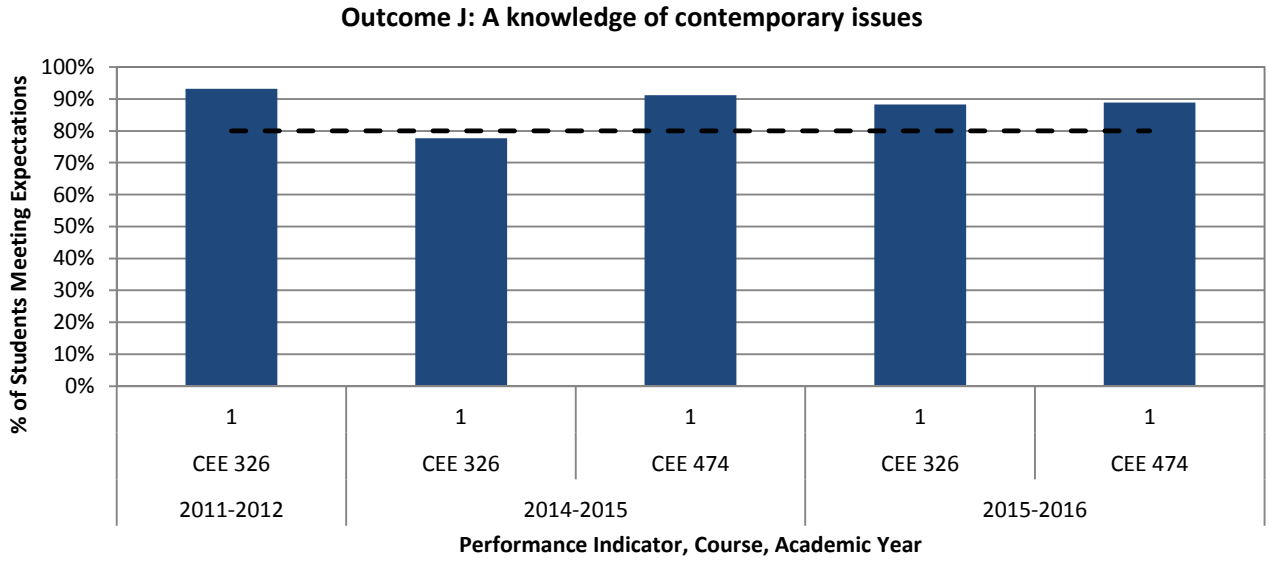


Figure 4-27. Student Outcome (j) results for 2011 and 2014-2016.

Outcome J

Outcome J: Current Assessment Plan Annual Evaluation Summary

Summary of Evaluation Process: Summative data for Student Outcome (j), a knowledge of contemporary issues, is measured using rubric (j) developed by the faculty. The data was primarily obtained from case studies and essays in CEE 326 and CEE 474. These assignments were selected to allow the students to identify contemporary issues that impact a given problem or design. Students who scored 3 or higher (75%) based on rubric (b) were deemed to meet or exceed expectations. The department goal is to have 80% of the students meet or exceed expectations. A summary of the previous actions, observations, and new action items recommended by the faculty during the annual assessment meetings are presented.

2014-15 (82% of students met expectations)

Previous Actions:

Observations:
Goal was achieved.

New Actions:
Include discussion of contemporary issues in all courses.

2015-16 (88% of students met expectations)

Previous Actions (82% 2014-15):
Include discussion of contemporary issues in all courses.

Observations:
Department goal was achieved

New Actions:
Continue incorporating contemporary issues in courses.

Outcome K

An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

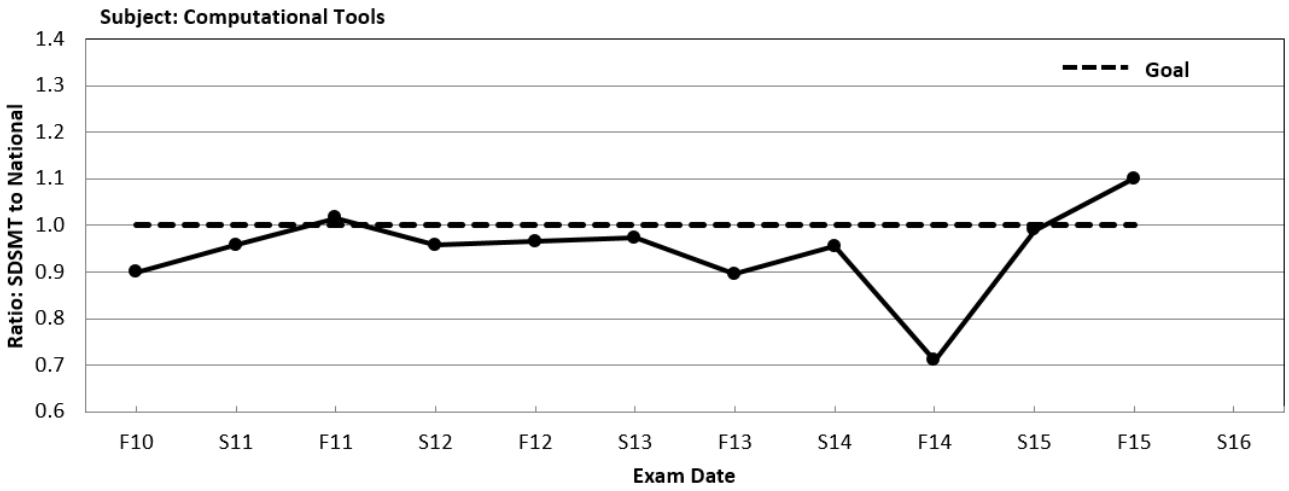
A summary of the percentage of students meeting or exceeding expectations over the review period (2011-2016) is given in Table 4-67 followed by a summary of the FE exam results related to outcome (k) in Table 4-68 with plotted results provided in Figure 4-28**.** Subsequent sections present the assessment results from the intermediate assessment and the current assessment plans along with assessment results/observations and action plans for continuous improvement.

Table 4-67. Outcome (k) Summary 2011-2016

Student Outcome	2011-2012	2012 – 2013	2013 – 2014	2014 – 2015	2015 – 2016
(k)	86%	66%	87%	89%	65%
	80%-100% of students meet or exceed expectations				
	70%-80% of students meet or exceed expectations				
	60%-70% of students meet or exceed expectations				
	Less than 60% of students meet or exceed expectations				

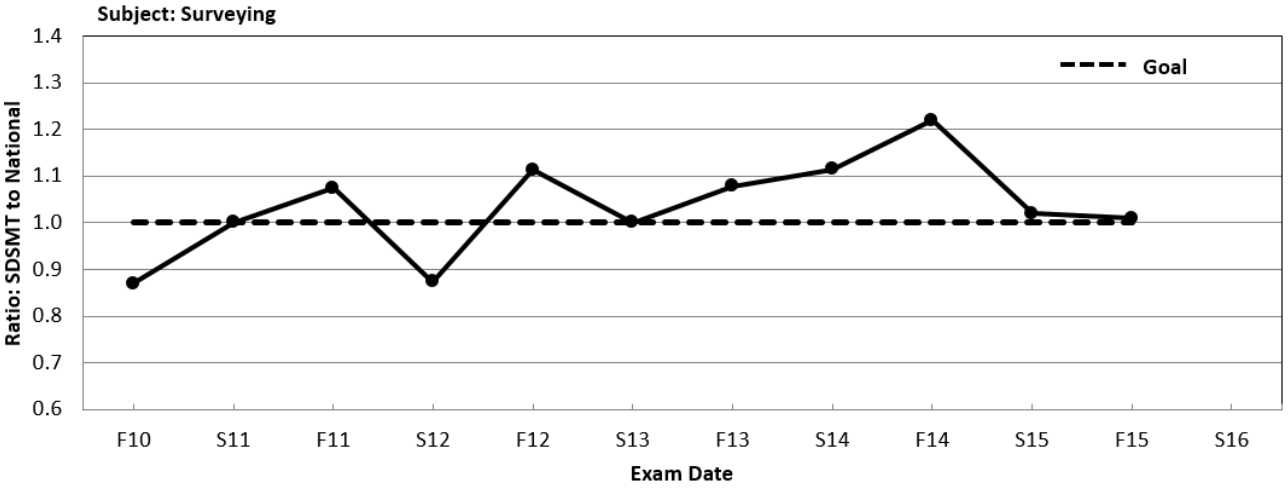
Table 4-68. FE Topics related to Outcome (k) 2010-2016

FE Topic	Outcome	Courses	10/11	11/12	12/13	13/14	14/15	F15
Computational Tools	(k)	CEE 284	0.94	0.99	0.97	0.91	0.90	1.10
Surveying	(k)	CEE 206	0.96	0.97	1.06	1.09	1.09	1.01
	Greater than 1.0							
	0.9 to 1.0							
	0.8 to 0.9							
	Less than 0.8							



(a)

Outcome K



(b)

Figure 4-28. Plots of FE results for each semester from 2010-2016 for subjects (a) Computational Tools and, (b) Surveying.

Outcome K

Intermediate Plan Results (2012-13 and 2013-14)

This section presents the results from the Intermediate Assessment plan (2012-2014). Data sources related to each performance indicator along with assessment instruments are provided in Table 4-69. A bar graph showing the percentage of students who met or exceeded expectations for each of the performance indicators is shown in Figure 4-29. A summary of the annual assessment results/observations as well as action items for continuous improvement are provided.

Table 4-69. Outcome (k) Data Sources 2012-2014

Performance Indicator	Rubric	Source: Instrument
1. Design development/ concept generation	EDR 2	CEE 464: Project Proposal
2. Design development/ concept selection	EDR 4	CEE 464/465: Progress Report 1 & 2
3. Engineering analysis and design	EDR 5	CEE 465: Progress report 2 & 3 and final report

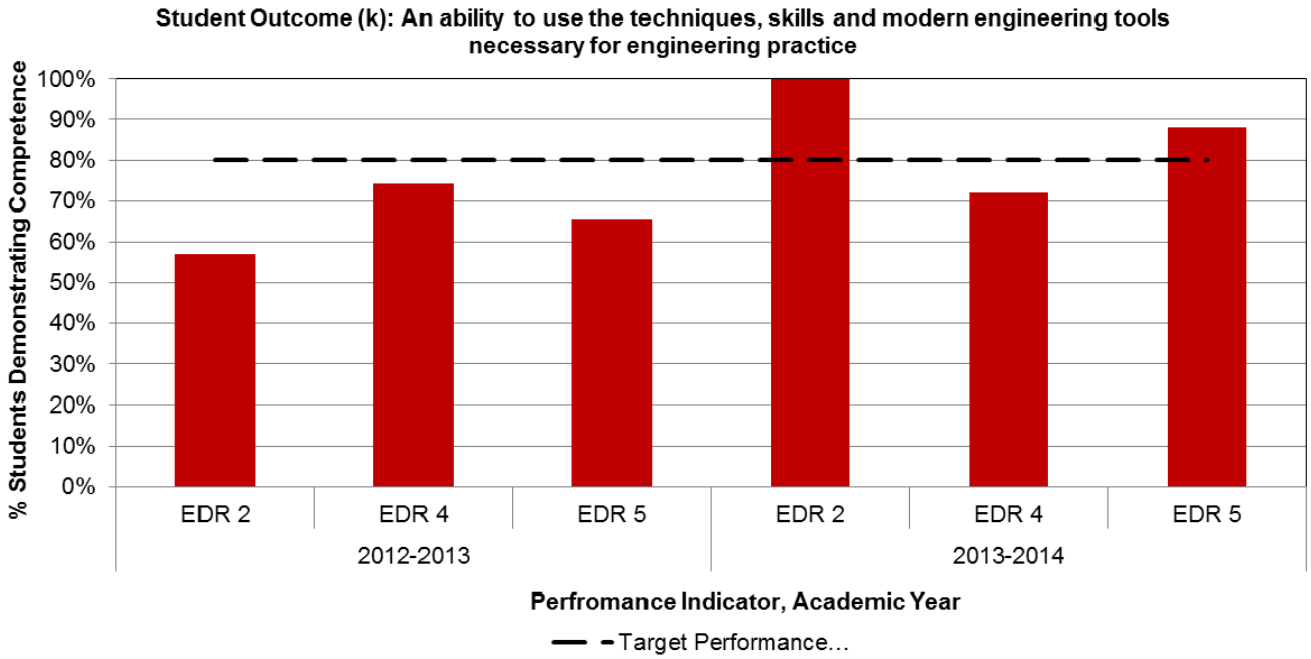


Figure 4-29. Student Outcome (k) results for 2012-2014.

Outcome K

Outcome K: ***Intermediate Assessment Plan Annual Evaluation Summary***

Summary of Evaluation Process: Summative data for Student Outcome (k), An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice, is measured by four assessment instruments. The first assessment rubric, EDR 2, focuses on design development and concept generation which is defined as the student's ability to use multiple strategies, approaches, and materials, to generate a variety of ideas and alternatives to systematically explore possible solution paths. The students' ability in this area was measured in CEE 464 using the students' project proposal for their senior design project. The second assessment rubric, EDR 4, focuses on design development and concept selection which is defined as the student's ability to methodically narrow down design choices in ways that refine concepts and lead to focusing on the most promising design solutions that incorporate relevant considerations identified in the Impact Analysis. The students' ability in this area was measured in CEE 464/465 using the students' first and second progress report for their senior design project. The third assessment rubric, EDR 5, focuses on engineering analysis which is defined as the student's ability to skillfully synthesize the results of modeling, simulation, and prototyping to define the design and/or reformulate the problem. The students' ability in this area was measured in CEE 465 using the students' second and third progress report and final report for their senior design project.

2012-13

Results/Observations: The capstone design course, CEE 465, was comprised of 35 students divided into eight teams. The performance of these 35 students (100% of the class) was assessed individually by the instructor, Dr. Damon Fick. 57% of the students met or exceeded expectations for Rubric 1 (EDR 2). 74% of the students met or exceeded expectations for Rubric 2 (EDR 4). 66% of the students met or exceeded expectations for Rubric 3 (EDR 5). This was the initial deployment of these assessment rubrics. Student results fell below our target level of 80% of students meeting or exceeding the expectation of performance at the "competent" level or "3" on a scale of 0 – 5. We anticipate that increased exposure of both faculty and students to the engineering design assessment concepts and rubrics will improve results. Future measurements will be performed by faculty assessment teams who will undergo a calibration process to develop inter-rater reliability and increase the validity of the assessment.

Actions: Performance indicators should be introduced in the context of the assessment rubrics (EDR 2, 4 and 5) in supporting courses. Faculty will be trained on the use of the rubrics and underlying principles in the fall semester. Faculty will report on the results of their implementation at the end of the fall semester assessment meeting.

2013-14

Results/Observations: Providing assessment rubrics to students resulted in a significant increase in the number of students meeting expectations. In order to get a better understanding of the curriculum as a whole it is recommended to go back to the previous assessment plan developed in 2010 in which assessments were conducted using courses from across the curriculum.

Actions:

1) Revert back to previous assessment plan.

Outcome K

Current Plan Results (2011-12, 2014-15, and 2015-16)

This section presents the results from the Current Assessment plan (2011 and 2014-2106). Data sources related to each performance indicator along with assessment instruments are provided in Table 4-70. The rubric used to evaluate each instrument in given in Table 4-71. A bar graph showing the percentage of students who met or exceeded expectations for each of the performance indicators is shown in Figure 4-30. A summary of the annual assessment results/observations as well as action items for continuous improvement are provided.

Table 4-70. Outcome (j) Data Sources 2011 and 2014-2016

Performance Indicator	Rubric	Source: Instrument
1 Selects and uses engineering techniques, skills and tools including computers to identify and solve engineering problems	Rubric (k)	CEE 336: Selected Exam and homework problems CEE 457: Select Exam Problems CEE 433: Select Exam Problems

Table 4-71. Outcome K Assessment Rubric

k. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Performance Indicators	Below expectations 1 (50%-63%)	Minimally acceptable 2 (63%-75%)	Meets expectations 3 (75%-88%)	Exceeds expectations 4 (88%-100%)
1. Selects and uses engineering techniques, skills and tools including computers to identify and solve engineering problems	No or only cursory attempt to apply techniques and tools for a specific engineering task	Good faith attempt at application of techniques and tools for a specific engineering task	Application of techniques and tools for a specific engineering task completed with difficulty, only minor errors preventing a correct numeric result	Software application of techniques and tools for a specific engineering task completed perfectly, correct numerical result

Outcome K

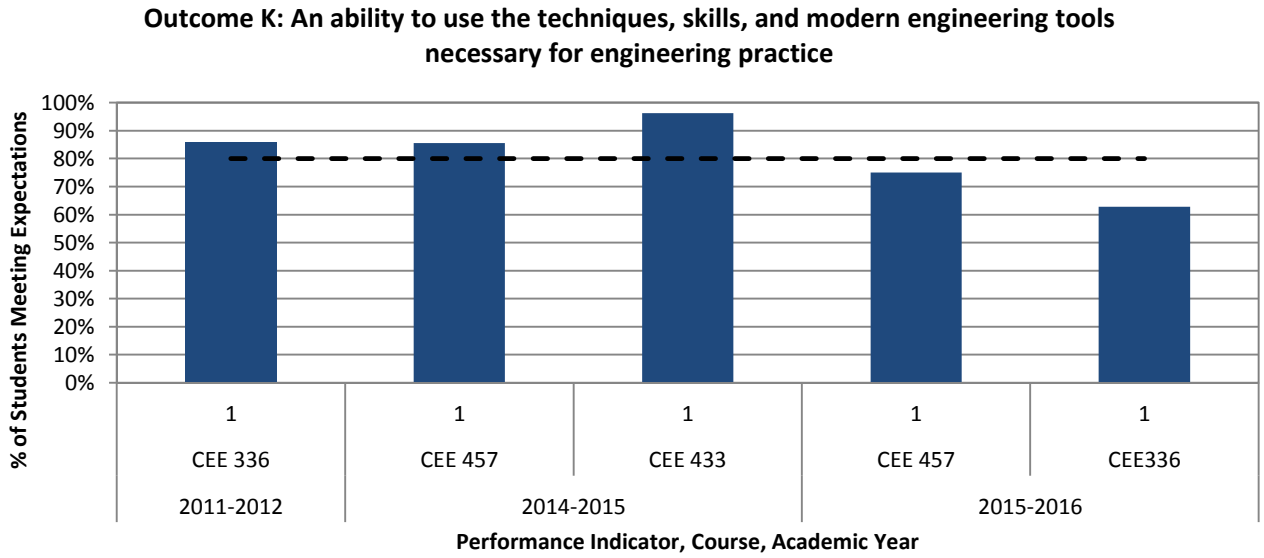


Figure 4-30. Student Outcome (k) results for 2011 and 2014-2016.

Outcome K

Outcome J: Current Assessment Plan Annual Evaluation Summary

Summary of Evaluation Process: Summative data for Student Outcome (k), an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice, is measured using rubric (k) developed by the faculty. The data was primarily obtained from selected exam problems in CEE 336, CEE 433 and CEE 457. These computational problems were selected to allow the students to demonstrate their ability to select and use engineering techniques, skills and tools including computers to identify and solve engineering problems. Students who scored 3 or higher (75%) based on rubric (k) were deemed to meet or exceed expectations. The department goal is to have 80% of the students meet or exceed expectations. In addition to course data, FE exam topics related to Outcome (k): Computational Tools and Surveying. A summary of the previous actions, observations, and new action items recommended by the faculty during the annual assessment meetings are presented.

2014-15 (89% of students met expectations)

Previous Actions:
None

Observations:
We provide lots of application in CE courses and students do well in this area.

New Actions:
None

2015-16 (65% of students met expectations)

Previous Actions (89% 2014-15):
None

Observations:
We provide lots of application in CE courses and students do well in this area.
CEE 336 students struggled to apply the appropriate tools to solve comprehensive problems. Similar issues were observed in CEE 457. Based on a survey of professors at the assessment meeting most courses are using MathCAD and Excel in their courses.

New Actions:
Continue using computational tools in courses.
Reinforce problem setup

5. Documentation of Results

The documentation of results for student outcome assessments as well as FE exam results are stored on the department network drive where they are accessible to the CE program faculty. Hard copies of these documents will be made available to the reviewer during the onsite visit.

B. Continuous Improvement

A summary of significant curriculum, program, and/or course changes which have been implemented as a result of the assessment process are presented in x. The table includes the corresponding student outcome, purpose of the change, and effectiveness of the change.

Table 4-72 Summary of Significant Continuous Improvement Changes

Action/Change	Outcome	Purpose	Effectiveness
Review sessions for EM 214, 321, and 331	A	Increase students ability to apply math and science to engineering problems and strengthen understanding of engineering principles	2015-16 was the first effective implementation of this program. Future reassessment is needed to determine effectiveness.
FE topic mapping to individual courses: Including mapping in course materials (see Table 4-73)	A and I	Increase FE exam performance above national average. FE topics are mapped to courses to help students recognize engineering principles which will be required for the exam.	Although FE exam scores have increased in recent years additional assessments are required based on the reduced number of students taking the FE exam.
FE exam review and practice exam required in CEE 463	A, E, and I	Reinforce the importance of life-long learning and professional licensure and well as strengthening students understanding of engineering principles.	Although FE exam scores have increased in recent years additional assessments are required based on the reduced number of students taking the FE exam.
Curriculum: Require Dynamics and Math 381	A and B	Provide better understanding of engineering principles and probability and statistics.	Future reassessment is required.

Table 4-73 Civil Engineering FE Topic to Course Mapping

Topic	Courses
1. Mathematics 7–11	
A. Analytic geometry	
B. Calculus	MATH 123/125/225
C. Roots of equations	CEE 284
D. Vector analysis	MATH 225
2. Probability and Statistics 4–6	**Math 381/CEE 284**
A. Measures of central tendencies and dispersions (e.g., mean, mode, standard deviation)	Math 381

B. Estimation for a single mean (e.g., point, confidence intervals)	Math 381
C. Regression and curve fitting	CEE 284
D. Expected value (weighted average) in decision making	Math 381
3. Computational Tools 4–6	**CEE 284**
A. Spreadsheet computations	CEE 284
B. Structured programming (e.g., if-then, loops, macros)	CEE 284
4. Ethics and Professional Practice 4–6	**CEE 463/325**
A. Codes of ethics (professional and technical societies)	CEE 463
B. Professional liability	CEE 463
C. Licensure	CEE 463
D. Sustainability and sustainable design	CEE 325
E. Professional skills (e.g., public policy, management, and business)	CEE 463
F. Contracts and contract law	CEE 463
5. Engineering Economics 4–6	**IENG 302**
A. Discounted cash flow (e.g., equivalence, PW, equivalent annual worth, FW, rate of return)	IENG 302
B. Cost (e.g., incremental, average, sunk, estimating)	IENG 302
C. Analyses (e.g., breakeven, benefit-cost, life cycle)	IENG 302
D. Uncertainty (e.g., expected value and risk)	IENG 302
6. Statics 7–11	**EM 214**
A. Resultants of force systems	EM 214
B. Equivalent force systems	EM 214
C. Equilibrium of rigid bodies	EM 214
D. Frames and trusses	EM 214
E. Centroid of area	EM 214
F. Area moments of inertia	EM 214
G. Static friction	EM 214
7. Dynamics 4–6	**ME 221**
A. Kinematics (e.g., particles and rigid bodies)	ME 221
B. Mass moments of inertia	ME 221
C. Force acceleration (e.g., particles and rigid bodies)	ME 221
D. Impulse momentum (e.g., particles and rigid bodies)	ME 221
E. Work, energy, and power (e.g., particles and rigid bodies)	ME 221
8. Mechanics of Materials 7–11	**EM 321**
A. Shear and moment diagrams	EM 321
B. Stresses and strains (e.g., axial, torsion, bending, shear, thermal)	EM 321
C. Deformations (e.g., axial, torsion, bending, thermal)	EM 321
D. Combined stresses	EM 321
E. Principal stresses	EM 321
F. Mohr's circle	EM 321
G. Column analysis (e.g., buckling, boundary conditions)	EM 321
H. Composite sections	EM 321
I. Elastic and plastic deformations	EM 321
J. Stress-strain diagrams	EM 321
9. Materials 4–6	**CEE 316**
A. Mix design (e.g., concrete and asphalt)	CEE 316
B. Test methods and specifications (e.g., steel, concrete, aggregates, asphalt, wood)	CEE 316
C. Physical and mechanical properties of concrete, ferrous and nonferrous metals, masonry, wood, engineered materials (e.g., FRP, laminated lumber, wood/plastic composites), and asphalt	CEE 316
10. Fluid Mechanics 4–6	**EM 331**
A. Flow measurement	EM 331
B. Fluid properties	EM 331
C. Fluid statics	EM 331
D. Energy, impulse, and momentum equations	EM 331
11. Hydraulics and Hydrologic Systems 8–12	**CEE 336/337**

A. Basic hydrology (e.g., infiltration, rainfall, runoff, detention, flood flows, watersheds)	CEE 337
B. Basic hydraulics (e.g., Manning equation, Bernoulli theorem, open-channel flow, pipe flow)	CEE 336
C. Pumping systems (water and wastewater)	CEE 336
D. Water distribution systems	CEE 336
E. Reservoirs (e.g., dams, routing, spillways)	CEE 336
F. Groundwater (e.g., flow, wells, drawdown)	CEE 336
G. Storm sewer collection systems	CEE 336
12. Structural Analysis 6–9	**CEE 353**
A. Analysis of forces in statically determinant beams, trusses, and frames	CEE 353
B. Deflection of statically determinant beams, trusses, and frames	CEE 353
C. Structural determinacy and stability analysis of beams, trusses, and frames	CEE 353
D. Loads and load paths (e.g., dead, live, lateral, influence lines and moving loads, tributary areas)	CEE 353
E. Elementary statically indeterminate structures	CEE 353
13. Structural Design 6–9	**CEE 453/456**
A. Design of steel components (e.g., codes and design philosophies, beams, columns, beam-columns, tension members, connections)	CEE 453
B. Design of reinforced concrete components (e.g., codes and design philosophies, beams, slabs, columns, walls, footings)	CEE 456
14. Geotechnical Engineering 9–14	**CEE 346/347/447/448**
A. Geology	GEOE 211/GEO 201
B. Index properties and soil classifications	CEE 346
C. Phase relations (air-water-solid)	CEE 346
D. Laboratory and field tests	CEE 346
E. Effective stress (buoyancy)	CEE 346
F. Stability of retaining walls (e.g., active pressure/passive pressure)	CEE 347/448
G. Shear strength	CEE 346
H. Bearing capacity (cohesive and noncohesive)	CEE 347/CEE 447
I. Foundation types (e.g., spread footings, deep foundations, wall footings, mats)-CEE 447	CEE 447
J. Consolidation and differential settlement	CEE 347/447
K. Seepage/flow nets	CEE 346/448
L. Slope stability (e.g., fills, embankments, cuts, dams)	CEE 347/448
M. Soil stabilization (e.g., chemical additives, geosynthetics)	CEE 347/448
N. Drainage systems	
O. Erosion control	
15. Transportation Engineering 8–12	**CEE 468**
A. Geometric design of streets and highways	CEE 468
B. Geometric design of intersections	CEE 468
C. Pavement system design (e.g., thickness, subgrade, drainage, rehabilitation)	CEE 468
D. Traffic safety	CEE 468
E. Traffic capacity	CEE 468
F. Traffic flow theory	CEE 468
G. Traffic control devices	CEE 468
H. Transportation planning (e.g., travel forecast modeling)	CEE 468
16. Environmental Engineering 6–9	**CEE 326/327**
A. Water quality (ground and surface)	CEE 326
B. Basic tests (e.g., water, wastewater, air)	CEE 327
C. Environmental regulations	CEE 326
D. Water supply and treatment	CEE 326
E. Wastewater collection and treatment	CEE 326
17. Construction 4–6	**CEE 474**
A. Construction documents	CEE 474
B. Procurement methods (e.g., competitive bid, qualifications-based)	CEE 474
C. Project delivery methods (e.g., design-bid-build, design build, construction management, multiple prime)	CEE 474
D. Construction operations and methods (e.g., lifting, rigging, dewatering and pumping, equipment production, productivity analysis and improvement, temporary erosion control)	CEE 474
E. Project scheduling (e.g., CPM, allocation of resources)	CEE 474
F. Project management (e.g., owner/contractor/client relations)	CEE 474

G. Construction safety	CEE 474
H. Construction estimating	CEE 474
18. Surveying 4–6	**CEE 206**
A. Angles, distances, and trigonometry	CEE 206
B. Area computations	CEE 206
C. Earthwork and volume computations	CEE 206
D. Closure	CEE 206
E. Coordinate systems (e.g., state plane, latitude/longitude)	CEE 206
F. Leveling (e.g., differential, elevations, percent grades)	CEE 206