

## PROGRAM ASSESSMENT DATA AY2013-2014

UNITED STATES MILITARY ACADEMY  
DEPARTMENT OF CHEMISTRY AND LIFE SCIENCE  
CHEMICAL ENGINEERING PROGRAM  
November 5, 2014

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Note: This data is intended to allow completion of the faculty and advisory board surveys. Review the data first and then complete the survey questions based on the data shown here



### **Level of Achievement of Student Outcome 1:**

On completion of the chemical engineering program, our graduates will be able to apply knowledge of mathematics, science, and engineering.

#### *Assessment Instruments and Frequency:*

1. Chemical & Mechanical Engineering Coursework Embedded Indicators, once/yr.
2. Fundamentals of Engineering Examination, once/yr.
3. End-of-Semester Student Surveys, once/semester.
4. Chemical Engineering Program Exit Survey, once/yr.

#### *Assessment Results:*

1. Chemical & Mechanical Engineering Coursework Embedded Indicators

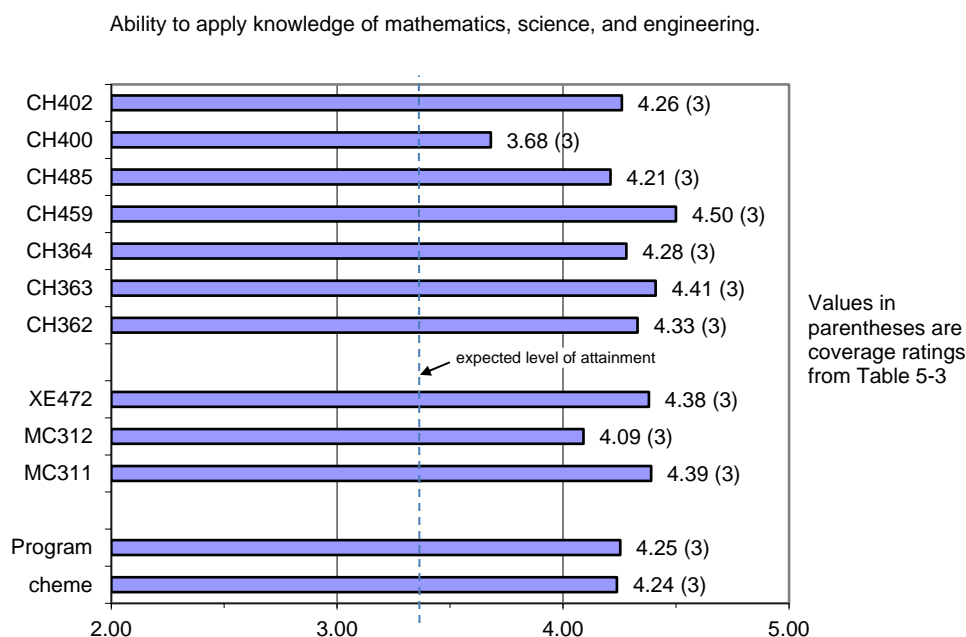


Figure 1-1. Coursework Embedded Indicator results for Student Outcome 1.

2. Fundamentals of Engineering Examination (FEE). According to the 2014 report from NCEES, 12 out of 13, or 92%, of the students in the Class of 2014 took and passed the FE Exam. Historically, this compares to 2013 (93%), 2012 (92%), 2011 (81%), 2010 (100%), 2009 (55%), 2008 (85%), and 2007 (88%). Our five-year running average is 91.6%. The national average percentage of chemical engineering examinees passing is 86%, and this is our expected level of attainment. We are therefore ~6% above the national average.

### 3. End of Semester Student Surveys

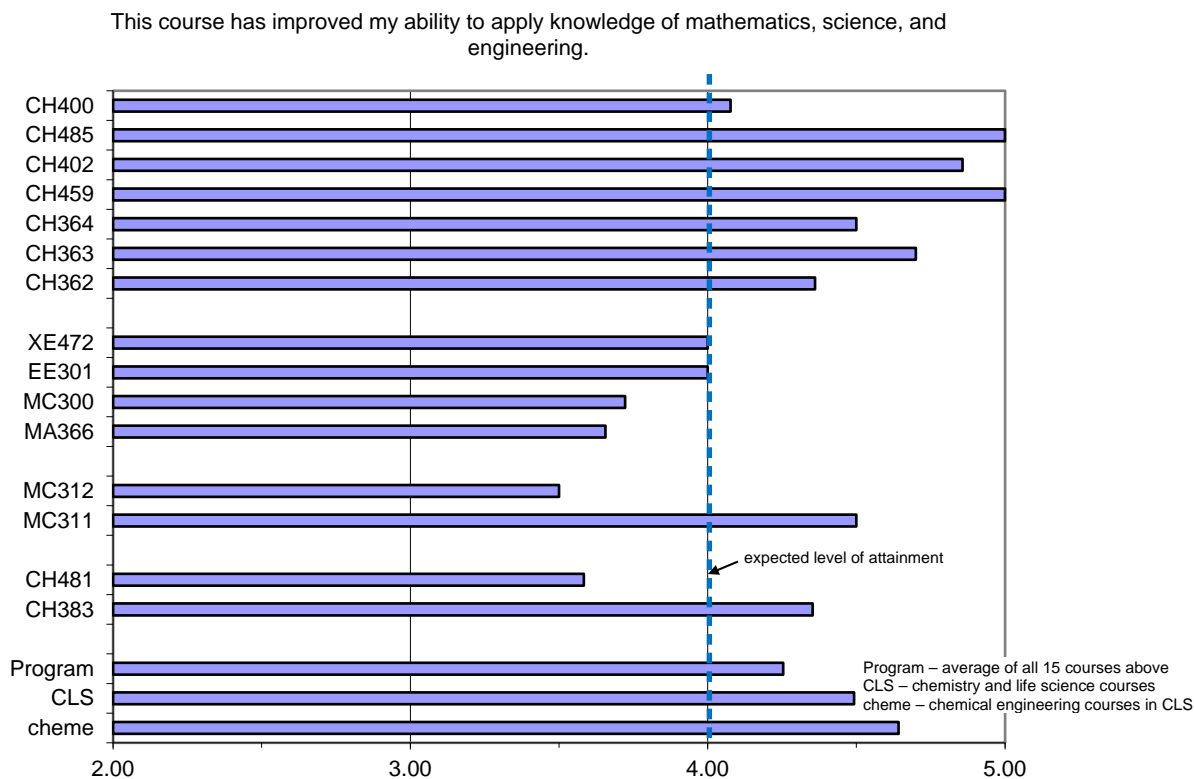


Figure 1-2. End-of-Semester Student Survey responses for Student Outcome 1.

4. Chemical Engineering Program Exit Survey. This survey is issued to the firsties at the end of their last semester. In this question, they were asked whether or not they agree with the statement “The program has prepared me to apply knowledge of math, science and engineering.” All 13 cadets replied that they strongly agreed (score = 5/5). This equates to a mean score of 5.00/5.00 for the 13 cadets, and the expected level of attainment on this survey is 4.00/5.00.

### Level of Achievement of Student Outcome 2:

On completion of the chemical engineering program, our graduates will be able to design and conduct experiments, as well as analyze and interpret data.

#### *Assessment Instruments and Frequency:*

1. Chemical & Mechanical Engineering Coursework Embedded Indicators, once/yr.
2. End-of-Semester Student Surveys, once/semester.
3. Chemical Engineering Program Exit Survey, once/yr.
4. Course Grades in CH459 Unit Operations Laboratory, once/yr.

#### *Assessment Results:*

1. Chemical & Mechanical Engineering Coursework Embedded Indicators

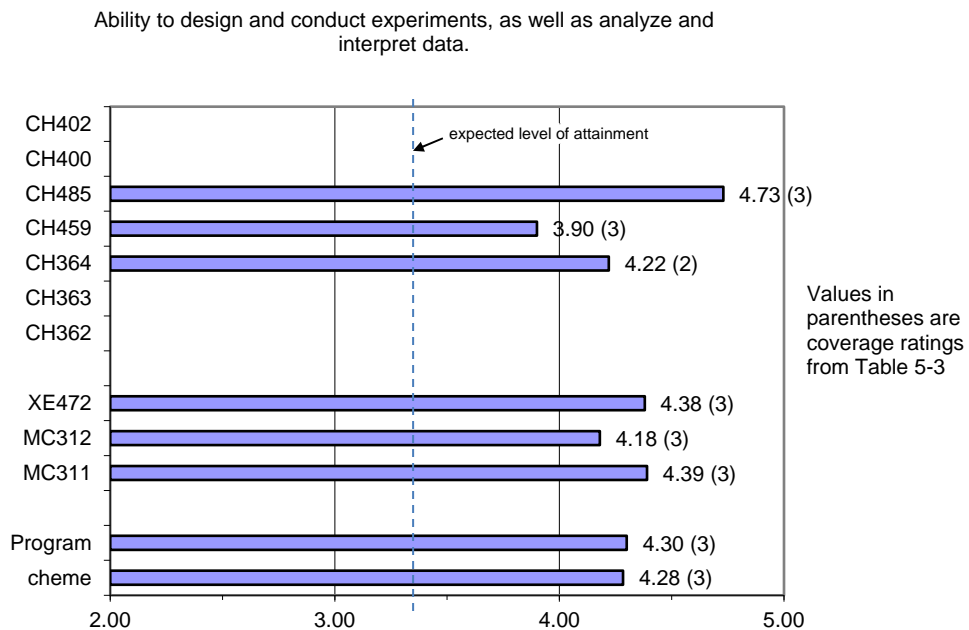


Figure 2-1. Coursework Embedded Indicator results for Student Outcome 2.

## 2. End of Semester Student Surveys

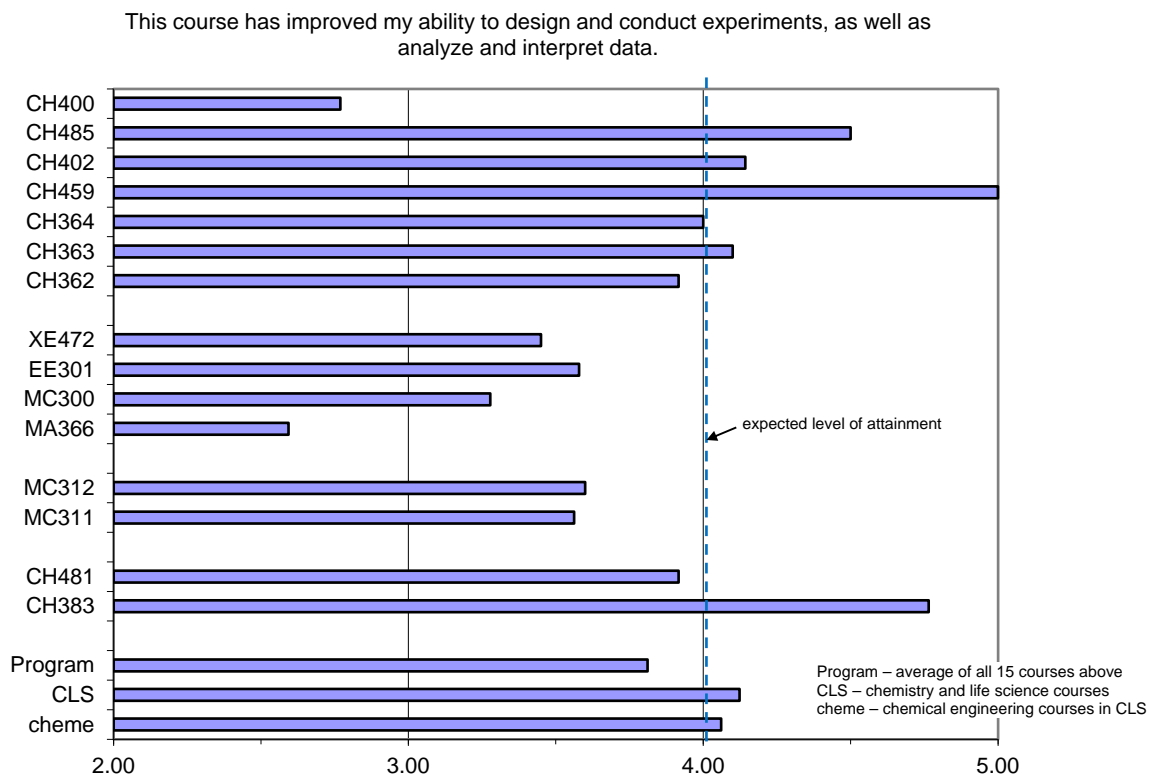


Figure 2-2. End-of-Semester Student Survey responses for Student Outcome 2.

3. Chemical Engineering Program Exit Survey. As stated earlier, this survey is given to the firsties at the end of their last semester. In this question, they were asked whether or not they agree with the statement “The program has prepared me to design and conduct experiments, as well as analyze and interpret data.” All 13 cadets replied that they either agreed or strongly agreed, and 12/13 replied that they strongly agreed (score = 5/5). This equates to a mean score of 4.92/5.00 for the 13 cadets. The expected level of attainment on this survey is 4.00/5.00.
4. The average course grade in CH459 Chemical Engineering Laboratory was  $3.87 \pm 0.44$  (n=13), compared to  $3.59 \pm 0.47$  (n=14) for AY13,  $3.64 \pm 0.40$  (n=13) for AY12,  $3.41 \pm 0.34$  (n=16) for AY11,  $3.26 \pm 0.69$  (n=13) for AY10,  $3.82 \pm 0.29$  (n=13) in AY09 and  $3.48 \pm 0.56$  (n=11) in AY08. There were no failures over the last five years. The 5-year running average for the previous five years is 3.55, and this is our expected level of attainment. This year’s score was 0.04 above the five year running average.

### Level of Achievement of Student Outcome 3:

On completion of the chemical engineering program, our graduates will be able to design a system, component, or process to meet desired needs within economic, environmental, social, political, ethical, health and safety, manufacturing, and sustainability constraints.

#### *Assessment Instruments and Frequency:*

1. Chemical & Mechanical Engineering Coursework Embedded Indicators, once/yr.
2. End of Semester Student Surveys, once/semester.
3. Chemical Engineering Program Exit Survey, once/yr.
4. Course Grades in CH402 Chemical Engineering Process Design, once/yr.

#### *Assessment Results:*

1. Chemical & Mechanical Engineering Coursework Embedded Indicators

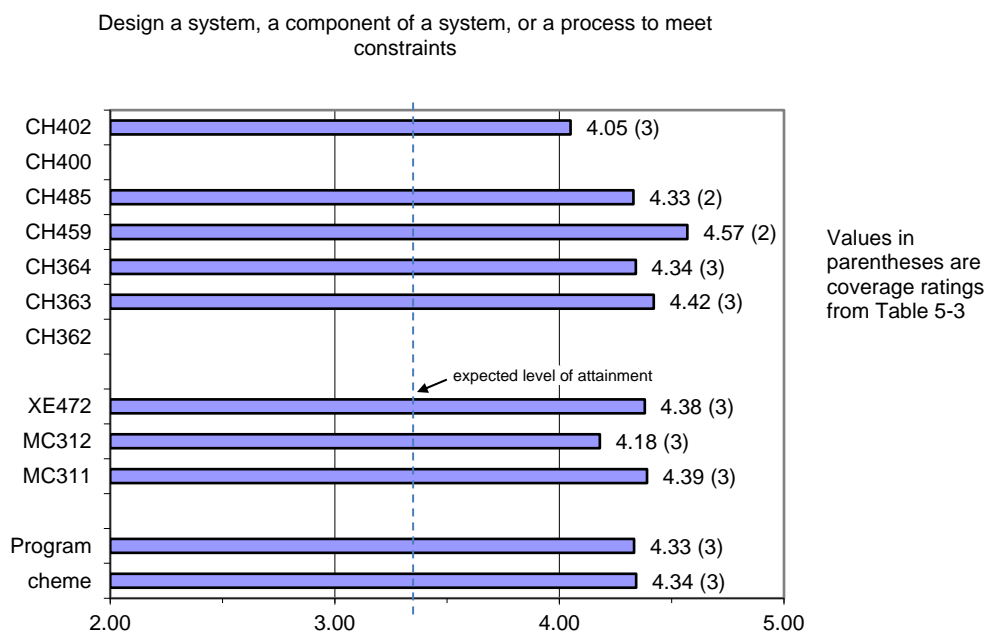


Figure 3-1. Coursework Embedded Indicator results for Student Outcome 3.

## 2. End of Semester Student Surveys

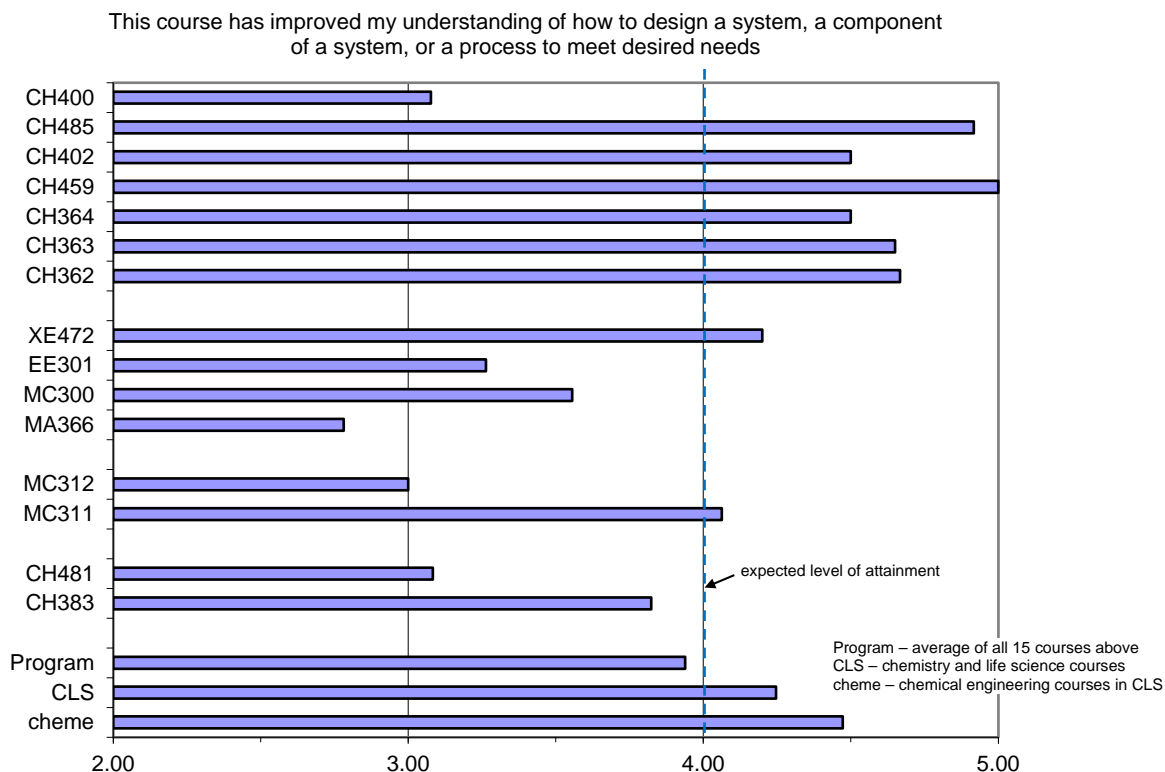


Figure 3-2. End-of-Semester Student Survey responses for Student Outcome 3.

3. Chemical Engineering Program Exit Survey. As stated earlier, this survey is given to the firsties at the end of their last semester. In this question, they were asked whether or not they agree with the statement “The program has prepared me to design a system, component or process to meet desired needs within specified constraints.” All 13 cadets replied that they either agreed or strongly agreed, and 12/13 replied that they strongly agreed (score = 5/5). This equates to a mean score of 4.92/5.00 for the 13 cadets. The expected level of attainment on this survey is 4.00/5.00.
4. The average course grade in CH402 Chemical Engineering Process Design was  $3.23 \pm 0.71$  (n=13) for AY14, compared to  $3.64 \pm 0.55$  (n=14) for AY13,  $3.69 \pm 0.50$  for AY12,  $3.33 \pm 0.69$  (n=16) for AY11,  $3.26 \pm 0.69$  (n=13) for AY10,  $3.44 \pm 0.60$  (n=13) in AY09 and  $3.61 \pm 0.61$  (n=11) in AY08. There were no failures over the last five years. The 5-year running average for the previous five years is 3.43, and this is our expected level of attainment. This year’s score was 0.20 below the five year running average. Although this number is below the 5-year running average, it is well within the standard deviation.



**Level of Achievement of Student Outcome 4:**

On completion of the chemical engineering program, our graduates will be able to function on multidisciplinary teams.

***Assessment Instruments and Frequency:***

1. Chemical & Mechanical Engineering Coursework Embedded Indicators, once/yr.
2. End of Semester Student Surveys, once/semester.
3. Chemical Engineering Program Exit Survey, once/yr.
4. Multidisciplinary Skills Rubric, once/yr.

***Assessment Results:***

1. Chemical & Mechanical Engineering Coursework Embedded Indicators

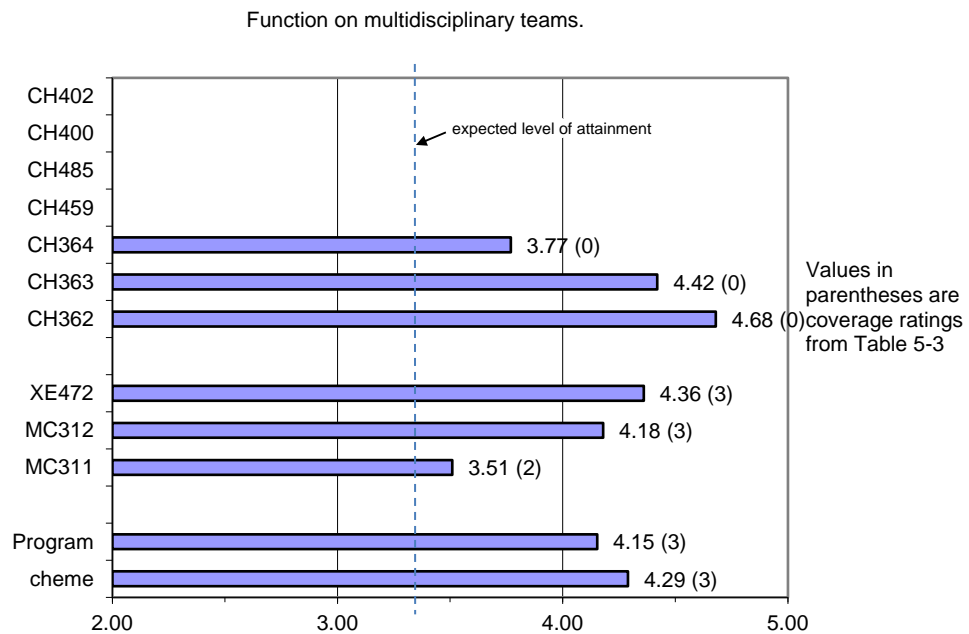


Figure 4-1. Coursework Embedded Indicator results for Student Outcome 4.

## 2. End of Semester Student Surveys

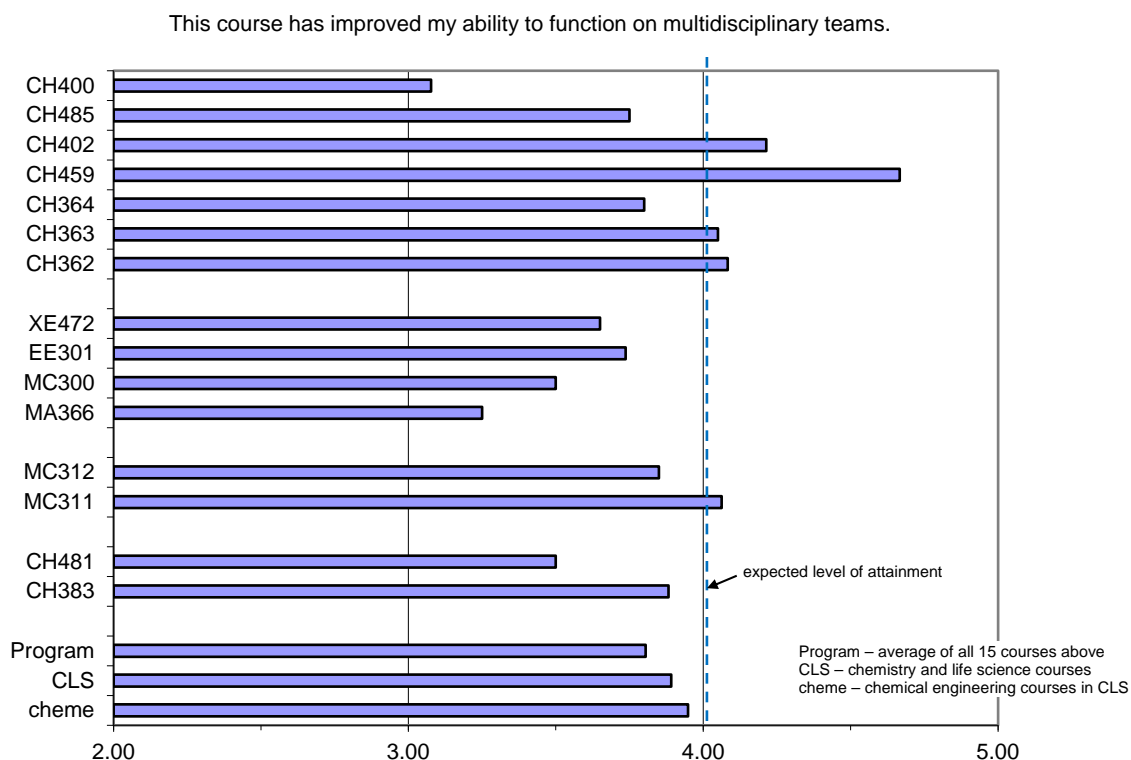


Figure 4-2. End-of-Semester Student Survey responses for Student Outcome 4.

3. Chemical Engineering Program Exit Survey. As stated earlier, this survey is given to the firsties at the end of their last semester. In this question, they were asked whether or not they agree with the statement “The program has prepared me to function on multidisciplinary teams.” All 13 cadets replied that they either agreed or strongly agreed, and 9/13 replied that they strongly agreed (score = 5/5). This equates to a mean score of 4.69/5.00 for the 13 cadets. The expected level of attainment on this survey is 4.00/5.00.
4. Multidisciplinary Skills Rubric. The rubric appears on page 9 below. It is designed to assess performance in four skills associated with the ability to function on multidisciplinary teams, namely technical competence, communication, organization, and teamwork. The rubrics are completed by the cadets after each laboratory exercise in CH459. They are asked to use the rubric to assess each of their team mates. The results are then averaged over the entire semester and reported in the rubric below. Results designated with a superscript “a” next to the numeric average are for cadets assessing their team mates (Group Self Assessment or GSA). The team leader also uses the rubric for a self-assessment (Leader Self Assessment or LSA), indicated with a superscript “b.” Referring to the rubric, the colors indicate the expected level of attainment, where green indicates that expectations are exceeded, yellow indicates that expectations are met, and red

indicates that improvement is needed. The expected level of attainment is 4.0. The results shown here indicate that the cadets are meeting or exceeding expectations in all cases.

Student Outcome 4 [ABET D]. On completion of the chemical engineering program, our graduates will be able to function on multidisciplinary teams.

Your Name: Bozic				Person Assessed: All Cadets in CH459					
Your Major: Chemical Engineering				Major of Person Assessed: Chemical Engineering					
	1 – Needs Improvement	1	2	3 – Meets Expectations	3	4	5 – Exceeds Expectations	5	N/A
Technical Competence	Some misunderstandings of the technical content.			Demonstrated knowledge of the technical content.		4.3 <sup>a</sup> 4.0 <sup>b</sup>	Exceptional knowledge of technical content.		
Communication	Lacked sensitivity and/or did not provide specific suggestions for improvement.			Effectively communicated important points.	3.7 <sup>b</sup>	4.3 <sup>a</sup>	Exceptional ability to explain important points. Very effectively communicated ideas for improvement.		
Organization	Was not prepared or did not give sufficient time to prepare.			Demonstrated effective organization during class.	3.9 <sup>b</sup>	4.2 <sup>a</sup>	Was exceptionally efficient, timely and responsive throughout the entire process.		
Teamwork	Demonstrated limited ability to see other perspectives or find common ground.			Worked collaboratively with team members to reach consensus.			Exceptional ability to help group find common ground or resolve conflict in order to ultimately reach consensus.	4.6 <sup>a</sup> 4.6 <sup>b</sup>	
Comments: There were a total of 9 individual assessments in this course. Each cadet was group leader at least twice. Footnote “a” designates the average of all Group Assessment (GSA) scores, while “b” designates average of all Leader Self Assessment (LSA) scores. The average standard deviation in all data is 0.48±0.23									

### Level of Achievement of Student Outcome 5:

On completion of the chemical engineering program, our graduates will be able to identify, formulate, and solve engineering problems.

#### *Assessment Instruments and Frequency:*

1. Chemical & Mechanical Engineering Coursework Embedded Indicators, once/yr.
2. Fundamentals of Engineering Examination, once/yr.
3. End of Semester Student Surveys, once/semester.
4. Chemical Engineering Program Exit Survey, once/yr.

#### *Assessment Results:*

1. Chemical & Mechanical Engineering Coursework Embedded Indicators

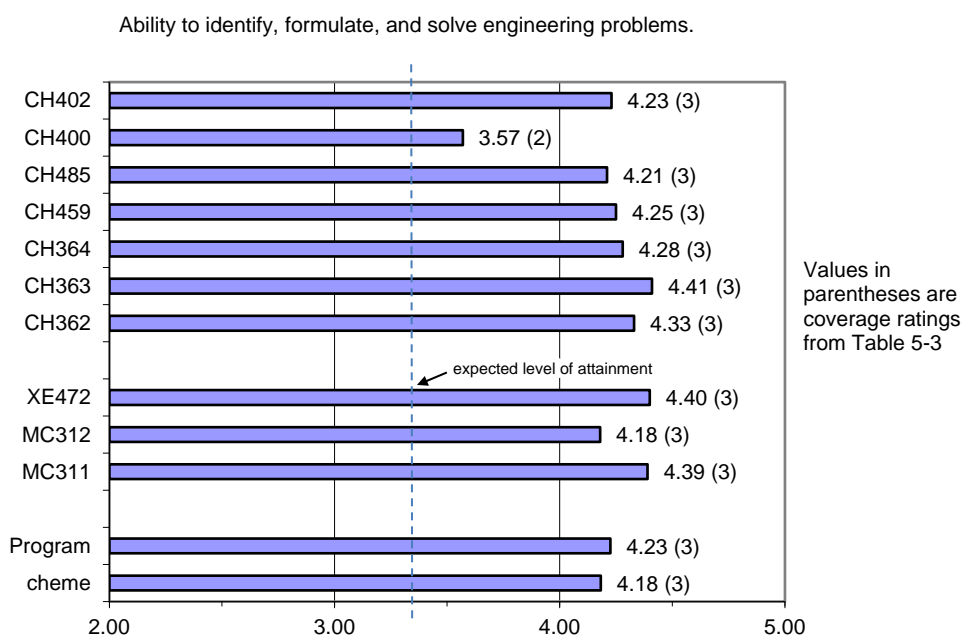


Figure 5-1. Coursework Embedded Indicator results for Student Outcome 5.

2. Fundamentals of Engineering Examination (FEE). According to the 2014 report from NCEES, 12 out of 13, or 92%, of the students in the Class of 2013 took and passed the FE Exam. Historically, this compares to 2013 (93%), 2012 (92%), 2011 (81%), 2010 (100%), 2009 (55%), 2008 (85%), 2007 (88%), and 2006 (80%). Our five-year running average is 91.6%. The national average percentage of chemical engineering examinees passing is 86%, and this is our expected level of attainment. We are therefore ~6% above the national average.

### 3. End of Semester Student Surveys

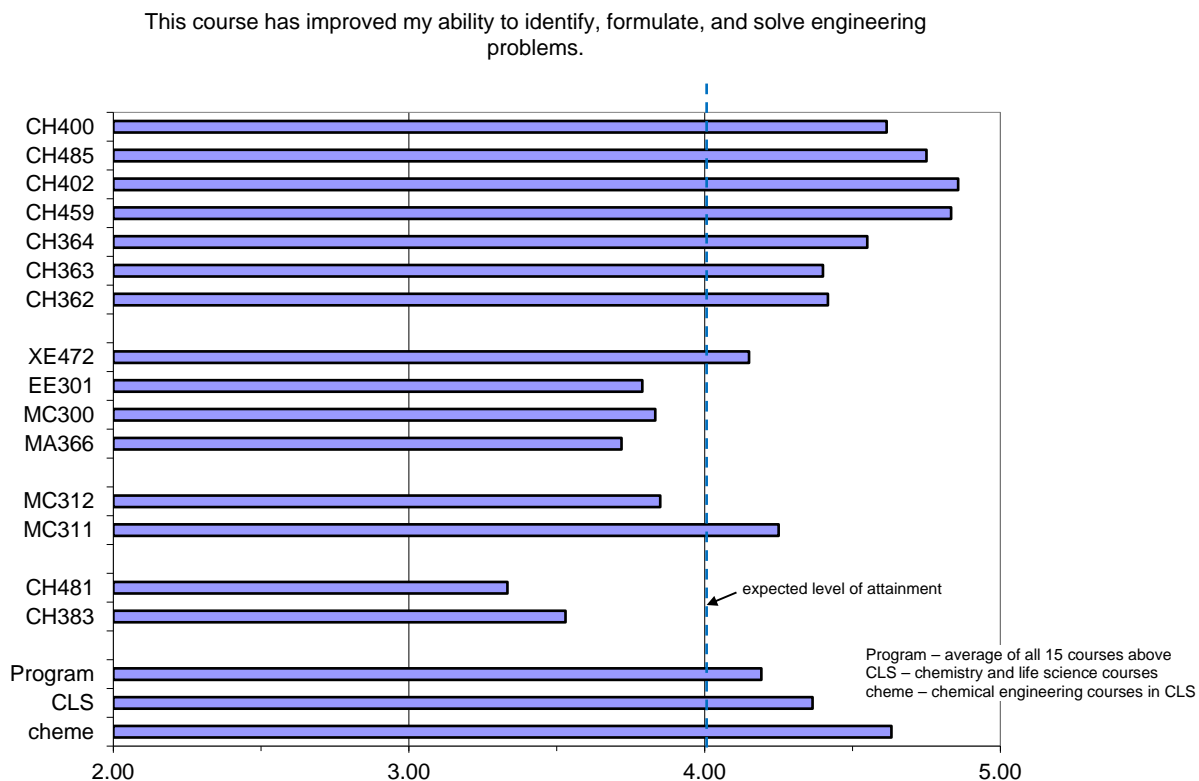


Figure 5-2. End-of-Semester Student Survey responses for Student Outcome 5.

4. Chemical Engineering Program Exit Survey. As stated earlier, this survey is given to the firsties at the end of their last semester. In this question, they were asked whether or not they agree with the statement “The program has prepared me to identify, formulate, and solve engineering problems.” All 13 cadets replied that they either agreed or strongly agreed, and 12/13 replied that they strongly agreed (score = 5/5). This equates to a mean score of 4.92/5.00 for the 13 cadets. The expected level of attainment on this survey is 4.00/5.00.

### Level of Achievement of Student Outcome 6:

On completion of the chemical engineering program, our graduates will be able to understand professional and ethical responsibilities.

#### *Assessment Instruments and Frequency:*

1. Chemical & Mechanical Engineering Coursework Embedded Indicators, once/yr.
2. Fundamentals of Engineering Examination, once/yr.
3. End of Semester Student Surveys, once/semester.
4. Chemical Engineering Program Exit Survey, once/yr.
5. Completion of Professional Military Ethics Education, once/yr.

#### *Assessment Results:*

1. Chemical & Mechanical Engineering Coursework Embedded Indicators

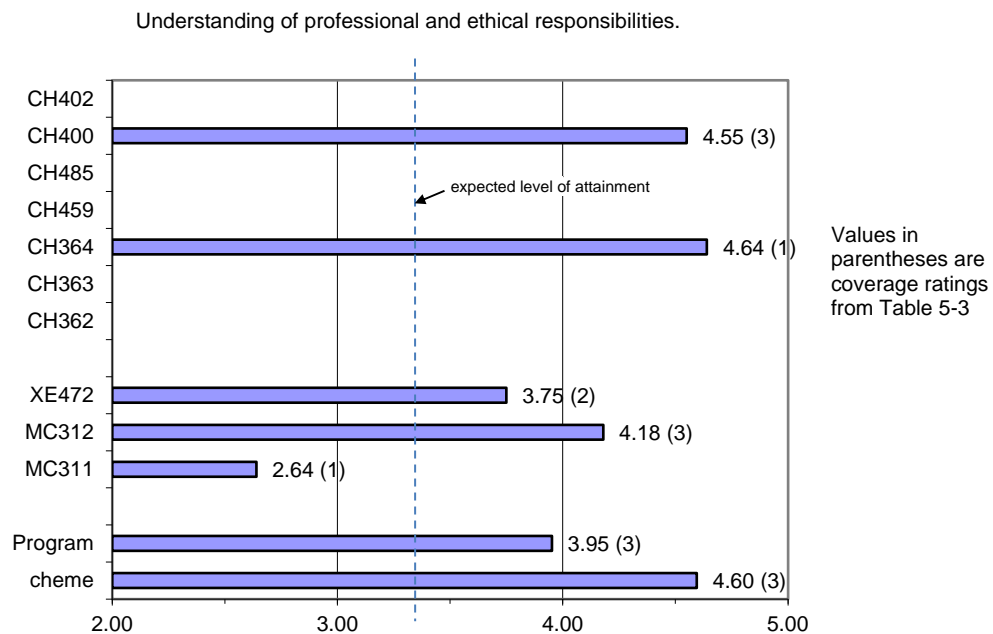


Figure 6-1. Coursework Embedded Indicator results for Student Outcome 6.

2. Fundamentals of Engineering Examination, Table 6-1. **As of AY14, NCEES has decided not to provide this information to non-accredited programs. Sample data is shown below for AY13. We expect this data to re-appear in AY16.**

Time	Subject	Outcome	Questions	USMA %	National % (expected level of attainment)
AM	Ethics and Business Practices	6	8	87	80

The national average pass rate of 80% in this subject is our expected level of attainment.

### 3. End of Semester Student Surveys

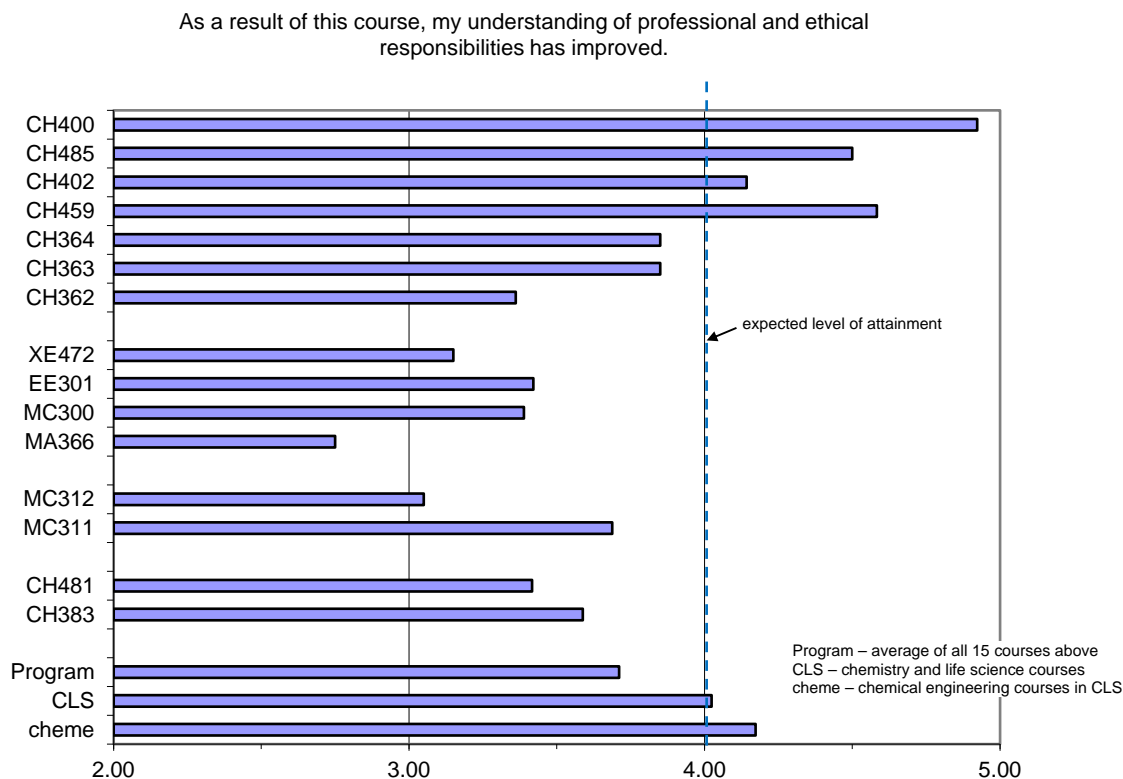


Figure 6-2. End-of-Semester Student Survey responses for Student Outcome 6.

4. Chemical Engineering Program Exit Survey. As stated earlier, this survey is given to the firsties at the end of their last semester. In this question, they were asked whether or not they agree with the statement “The program has prepared me to understand my professional and ethical responsibilities.” All 13 cadets replied that they either agreed or strongly agreed, and 8/13 replied that they strongly agreed (score = 5/5). This equates to a mean score of 4.46/5.00 for the 13 cadets. The expected level of attainment on this survey is 4.00/5.00.
5. Professional Military Ethics Education Formal training in honor and ethics takes place as part of the Professional Military Ethics Education (PME2) program during the academic year and during summer military instruction. The program is overseen by the Commandant of Cadets through the Simon Center for the Professional Military Ethic. PME2 tailors instruction to each of the four year-groups of cadets, who interact with faculty volunteers who share their perspectives and experience in the Armed Forces, with industry, and at other civilian institutions. Typically a PME2 team consists of members from the faculty and members from the Commandant’s staff. All 13 chemical engineering cadets successfully completed the 4-year Professional Military Ethics Education program.

### **Level of Achievement of Student Outcome 7:**

On completion of the chemical engineering program, our graduates will be able to communicate effectively, either orally or in written form.

#### *Assessment Instruments and Frequency:*

1. Chemical & Mechanical Engineering Coursework Embedded Indicators, once/yr.
2. End of Semester Student Surveys, once/semester.
3. Course Grades in CH459 Unit Operations Laboratory, once/yr.
4. Chemical Engineering Program Exit Survey, once/yr.

#### *Assessment Results:*

1. Chemical & Mechanical Engineering Coursework Embedded Indicators

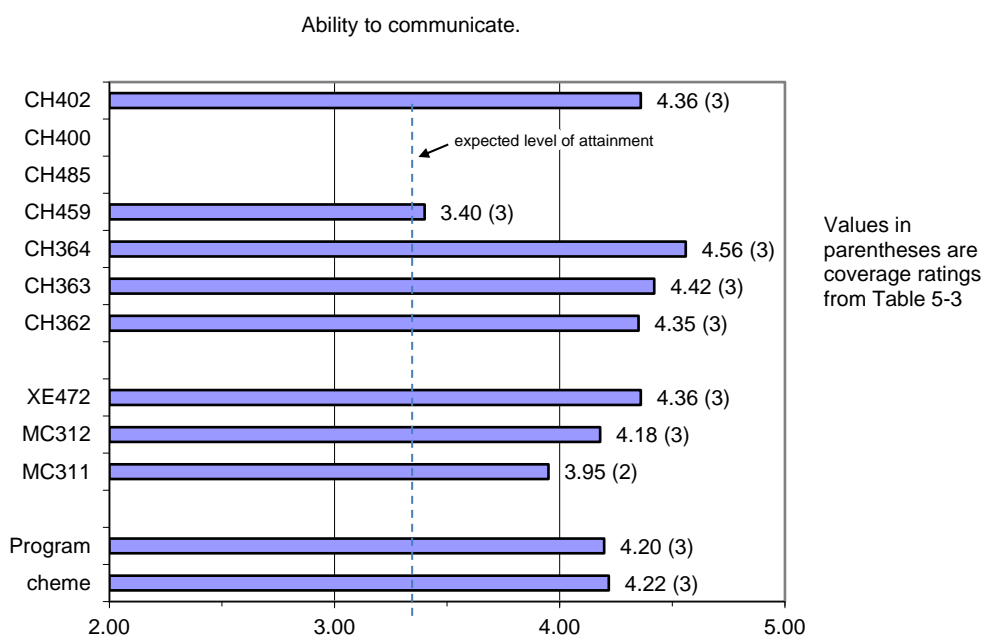


Figure 7-1. Coursework Embedded Indicator results for Student Outcome 7.



## 2. End of Semester Student Surveys

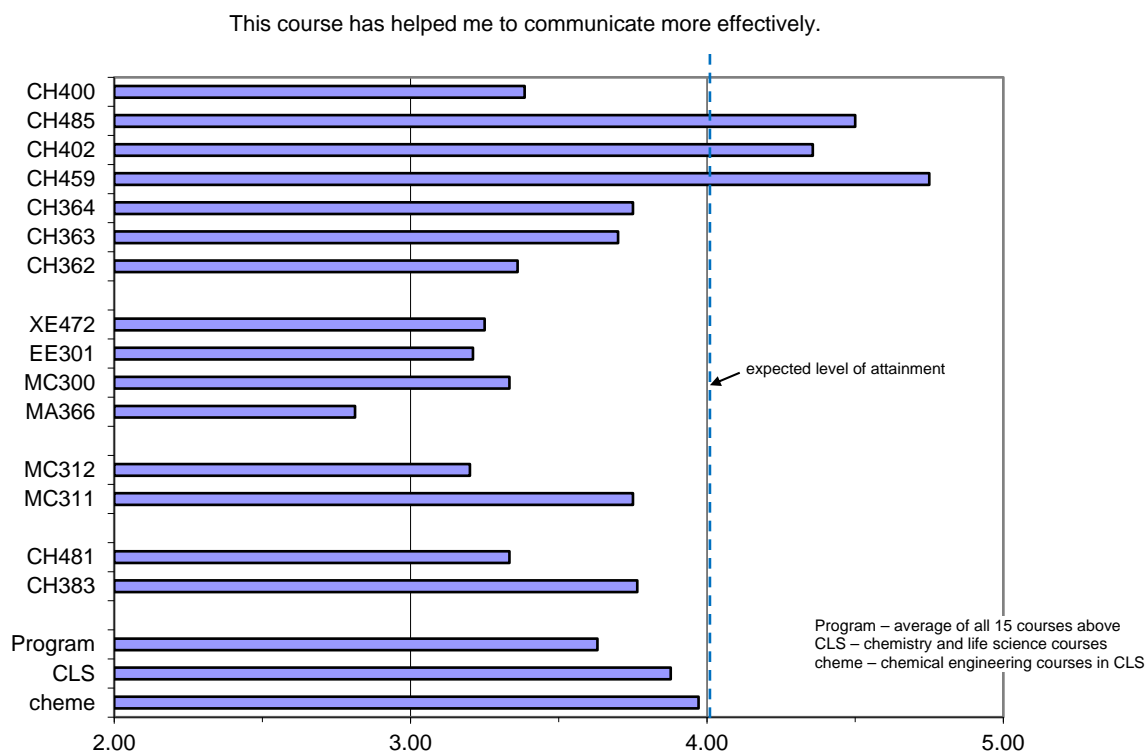


Figure 7-2. End-of-Semester Student Survey responses for Student Outcome 7.

- The average course grade in CH459 Chemical Engineering Laboratory was  $3.87 \pm 0.44$  ( $n=13$ ), compared to  $3.59 \pm 0.47$  for AY13,  $3.64 \pm 0.40$  ( $n=13$ ) for AY12,  $3.41 \pm 0.34$  ( $n=16$ ) for AY11,  $3.26 \pm 0.69$  ( $n=13$ ) for AY10,  $3.82 \pm 0.29$  ( $n=13$ ) in AY09 and  $3.48 \pm 0.56$  ( $n=11$ ) in AY08. There were no failures over the last five years. The 5-year running average for the previous five years is 3.54, and this is our expected level of attainment.
- Chemical Engineering Program Exit Survey. As stated earlier, this survey is given to the firsties at the end of their last semester. In this question, they were asked whether or not they agree with the statement “The program has prepared me to communicate effectively.” 12/13 cadets replied that they either agreed or strongly agreed, 8/13 replied that they strongly agreed (score = 5/5), and one cadet replied with a “neutral” (score = 3/5). This equates to a mean score of 4.54/5.00 for the 13 cadets. The expected level of attainment on this survey is 4.00/5.00.

### Level of Achievement of Student Outcome 8:

On completion of the chemical engineering program, our graduates will be able to understand the impact of engineering solutions in a global economic, environmental, and societal context.

#### *Assessment Instruments and Frequency:*

1. Chemical & Mechanical Engineering Coursework Embedded Indicators, once/yr.
2. Fundamentals of Engineering Examination, once/yr.
3. End of Semester Student Surveys, once/semester.
4. Chemical Engineering Program Exit Survey, once/yr.

#### *Assessment Results:*

1. Chemical & Mechanical Engineering Coursework Embedded Indicators

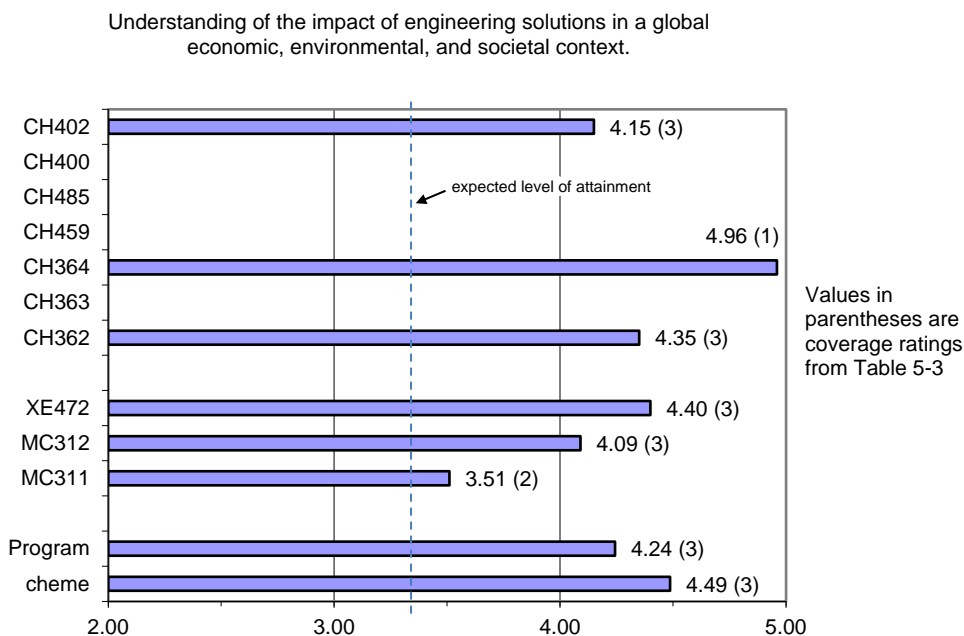


Figure 8-1. Coursework Embedded Indicator results for Student Outcome 8.

2. Fundamentals of Engineering Examination, Table 8-1. **As of AY14, NCEES has decided not to provide this information to non-accredited programs. Sample data is shown below for AY13. We expect this data to re-appear in AY16.**

Time	Subject	Outcome	Questions	USMA %	National % (expected level of attainment)
AM	Engineering Economics	8	10	69	65
PM	Process Design	8	6	78	76

The national average pass rates of 65 and 76% in these subjects are the metrics used as our expected level of attainment.

### 3. End of Semester Student Surveys

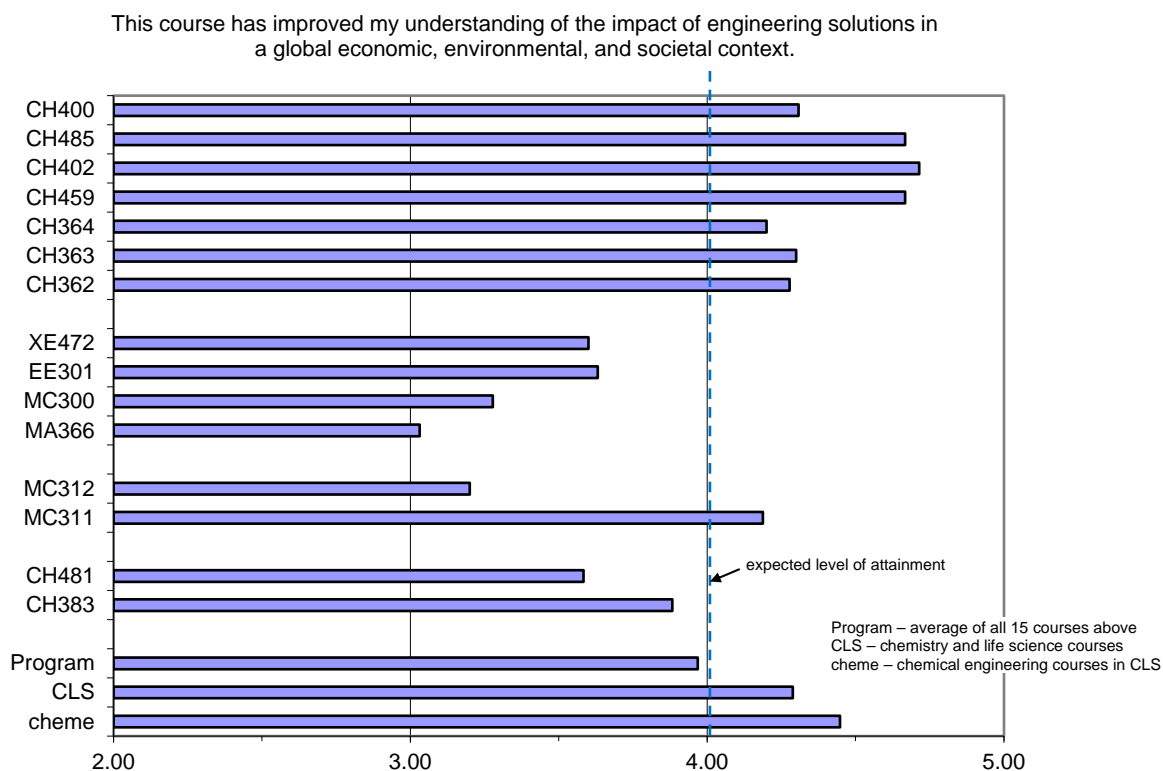


Figure 8-2. End-of-Semester Student Survey responses for Student Outcome 8.

4. Chemical Engineering Program Exit Survey. As stated earlier, this survey is given to the firsties at the end of their last semester. In this question, they were asked whether or not they agree with the statement “The program has prepared me to understand the impact of engineering solutions in a global economic, environmental, and societal context.” 12/13 cadets replied that they either agreed or strongly agreed, 11/13 replied that they strongly agreed (score = 5/5), and one cadet replied with a “neutral” (score = 3/5). This equates to a mean score of 4.77/5.00 for the 13 cadets. The expected level of attainment on this survey is 4.00/5.00.

### Level of Achievement of Student Outcome 9:

On completion of the chemical engineering program, our graduates will be able to recognize the need and develop the skills required for life-long learning.

#### *Assessment Instruments and Frequency:*

1. Chemical & Mechanical Engineering Coursework Embedded Indicators, once/yr.
2. Percent of eligible students taking the Fundamentals of Engineering Examination (FEE), once/yr.
3. End of Semester Student Surveys, once/semester.
4. Chemical Engineering Program Exit Survey, once/yr.
5. Lifelong Learning Skills Rubric, multiple times per year.

#### *Assessment Results:*

1. Chemical & Mechanical Engineering Coursework Embedded Indicators

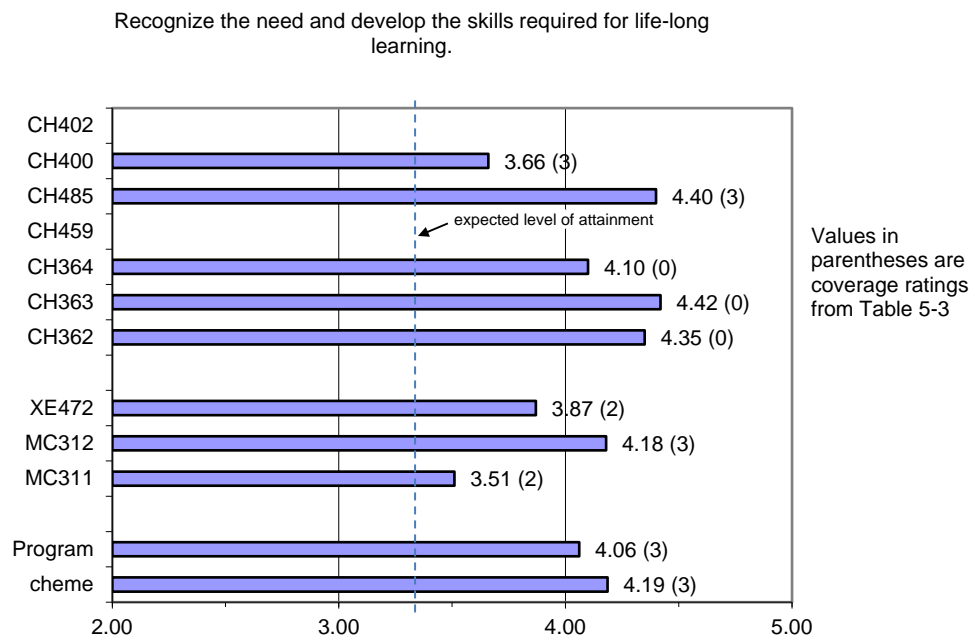


Figure 9-1. Coursework Embedded Indicator results for Student Outcome 9.

2. Percent of Eligible Cadets taking the Fundamentals of Engineering Examination (FEE). For the Class of 2014, there were 13 chemical engineering cadets (100% of the eligible cadets) who prepared for and took the FEE. This compares to 100% in 2013, 100% in 2012, 100% in 2011, 100% in 2010, 85% in 2009, 91% in 2008, 89% in 2007, and 100% in 2006. On average, approximately 25% of the graduating chemical engineers nationwide and 93% of the graduating engineers from all disciplines at the US Military academy take the FEE. Since all of our cadets prepare for the exam in CH400, our expected level of attainment is 100%.

### 3. End of Semester Student Surveys

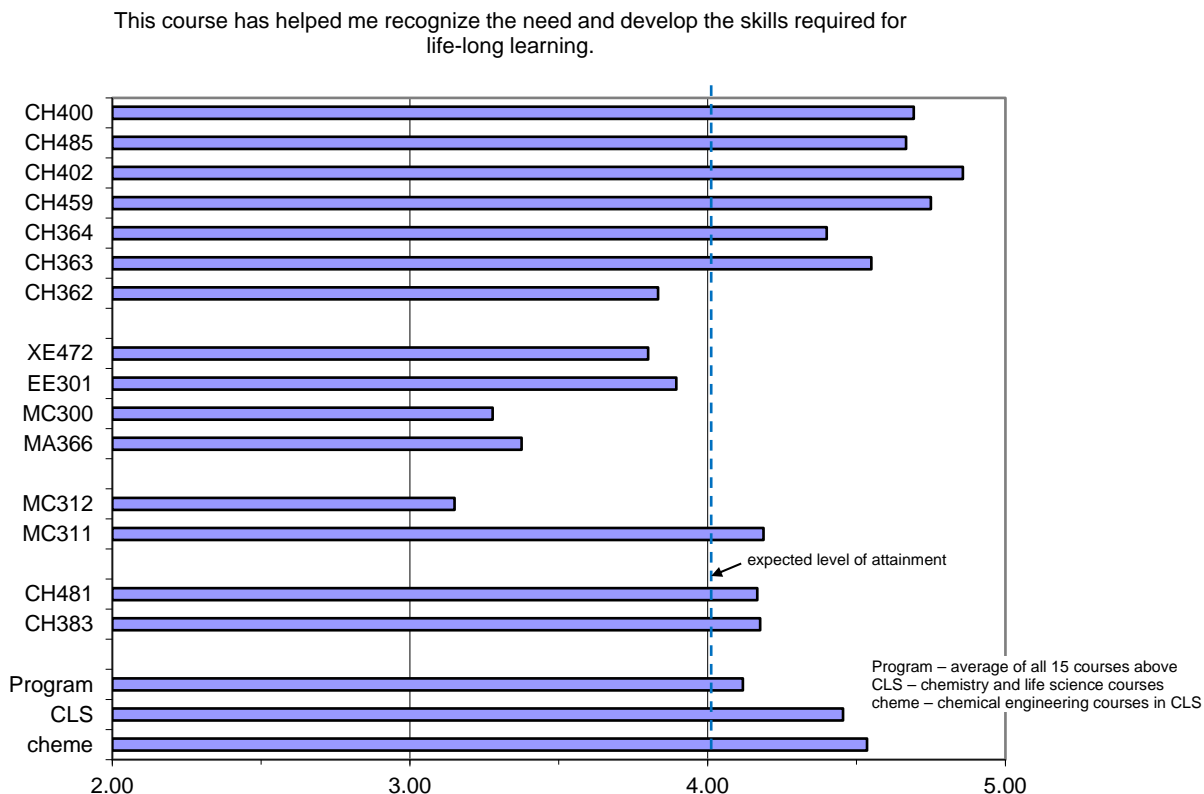


Figure 9-2. End-of-Semester Student Survey responses for Student Outcome 9.

4. Chemical Engineering Program Exit Survey. As stated earlier, this survey is given to the firsties at the end of their last semester. In this question, they were asked whether or not they agree with the statement “The program has prepared me to recognize the need and develop the skills required for life-long learning.” All 13 cadets replied that they either agreed or strongly agreed, and 10/13 replied that they strongly agreed (score = 5/5). This equates to a mean score of 4.77/5.00 for the 13 cadets. The expected level of attainment on this survey is 4.00/5.00.
5. Lifelong Learning Skills Rubric. The lifelong learning skills rubric was new for AY14 and was not described in the self study. It is designed to assess performance in four skills associated with recognizing the need and develop the skills required for life-long learning, namely, engagement of the cadet in pre-professional activities, recognition of the development of professional skills, demonstration of intellectual growth, and the ability to communicate these features to other professionals. The rubrics are completed by the instructors to assess the cadets in specific assignments in the program courses, namely Writing Assignments 1 and 5 in CH485. The results are shown in the rubric below, where we have reported averages for all of the cadets in the course. The expected levels of attainment are color-coded, with red indicating a need for improvement, and yellow and green

indicating that expectations are met or exceeded, respectively. The rubric containing the data for AY14 is shown below.

Your Name: <b>Biaglow</b>				Cadet Assessed All first-class chemical engineers (seniors)					
Your Position: <b>Professor, CH485</b>				Major of Cadet Assessed: <b>Chemical Engineering</b>					
	<b>1 – Needs Improvement</b>	<b>1</b>	<b>2</b>	<b>3 – Meets Expectations</b>	<b>3</b>	<b>4</b>	<b>5 – Exceeds Expectations</b>	<b>5</b>	<b>N/A</b>
<b>Engagement</b>	No evidence of pre-professional activities.			References pre-professional activities are lacking or connections to chemical engineering are weak or implied.	3.5 ±1.5		Uses examples of pre-professional chemical engineering activities.		
<b>Recognition</b>	Skills learned in chemical engineering courses taken in previous semesters are not listed.			Skills are listed, but the skills are vaguely described, or connection to chemical engineering concepts is not clear.			Identifies specific skills learned in chemical engineering courses.	4.7 ±0.7	
<b>Intellectual Growth</b>	Unable to identify new concepts learned this semester.			Changes are apparent in document, but connections to recent activities in chemical engineering are weak or implied.			Addition of multiple skills acquired this semester.	4.7 ±0.7	
<b>Communication</b>	Resume lacks organization or cohesion. Numerous grammatical errors that may interfere with meaning. Target audience unclear.			Occasional grammar errors that do not impede meaning. Demonstrates ability to write a basic resume, but document is uninteresting and flat.			Demonstrates an ability to effectively communicate in the resume format. Clear, concise content. Resume is interesting.	4.4 ±0.6	
Has this cadet achieved this outcome? (Y/N) <b>Yes.</b>	Comments: In general, resumes were very good. Cadets wrote resumes for Writing Assignment 1 at the beginning of the semester, and then updated these resumes for Writing Assignment 5 at the end of the semester. This allowed the instructor to measure growth as reflected by the improvements in the resumes over the semester. Final Grade: 4.3/5 = 86%						Assignment used for assessment: CH485 Writing Assignment 5 - Resumes		

**Level of Achievement of Student Outcome 10:**

On completion of the chemical engineering program, our graduates will be able to demonstrate knowledge of contemporary issues.

***Assessment Instruments and Frequency:***

1. Chemical & Mechanical Engineering Coursework Embedded Indicators, once/yr.
2. End of Semester Student Surveys, once/semester.
3. Chemical Engineering Program Exit Survey, once/yr.
4. Contemporary Issues Rubric, multiple times per year.

***Assessment Results:***

1. Chemical & Mechanical Engineering Coursework Embedded Indicators

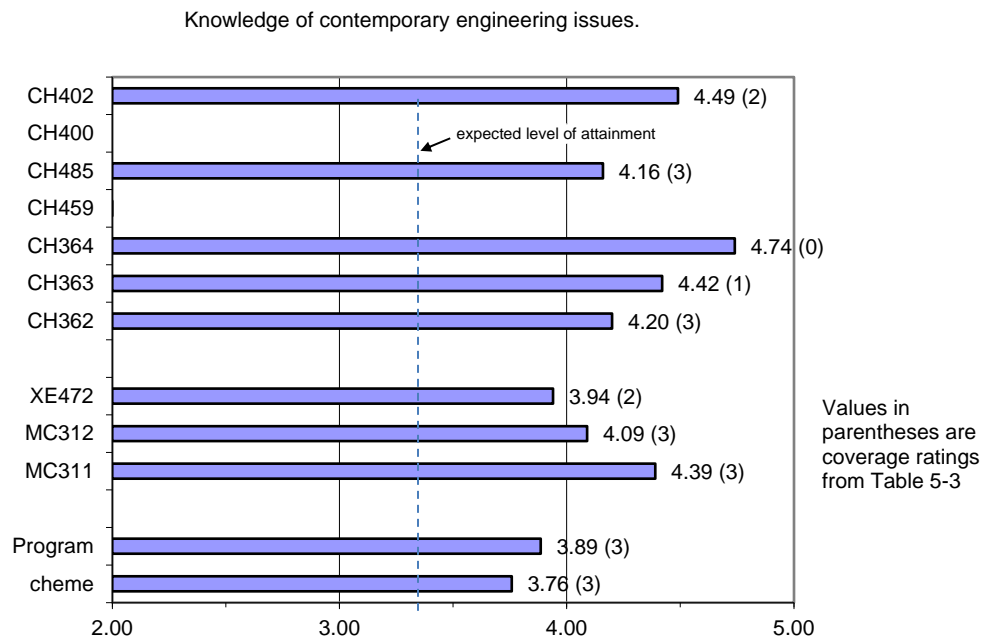


Figure 10-1. Coursework Embedded Indicator results for Student Outcome 10.

## 2. End of Semester Student Surveys

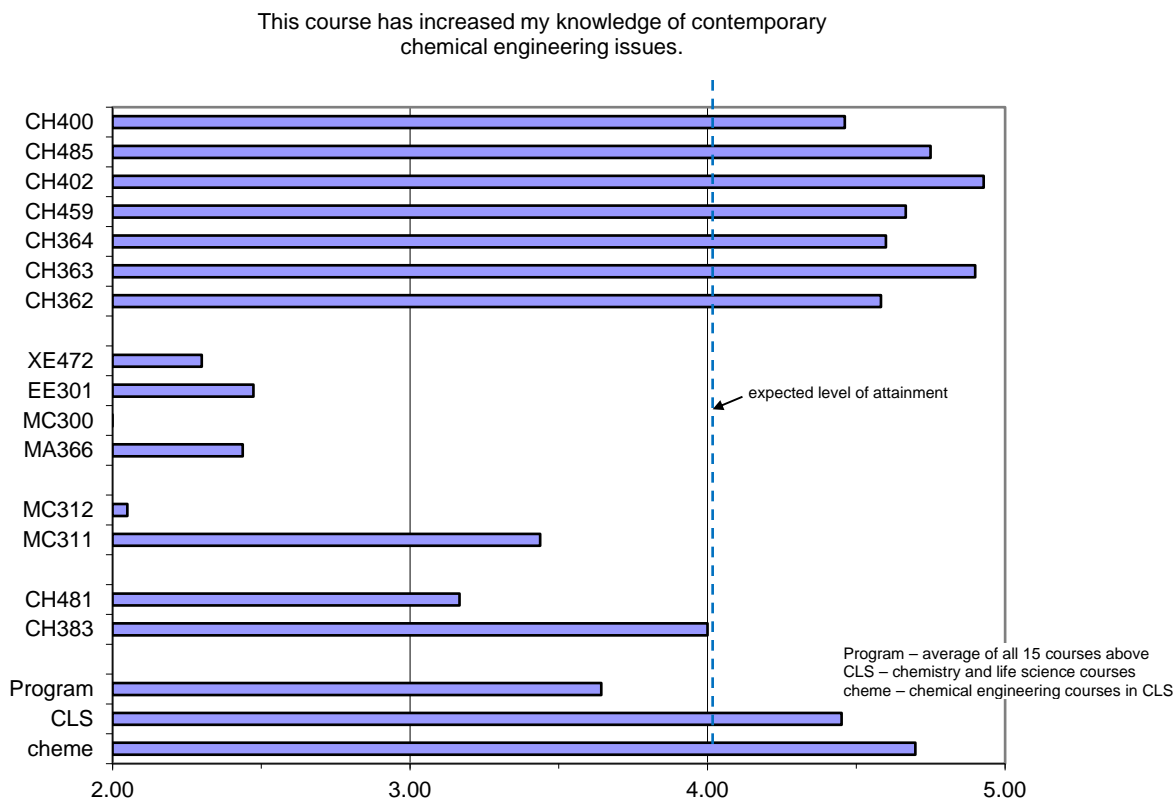


Figure 10-2. End-of-Semester Student Survey responses for Student Outcome 10.

3. Chemical Engineering Program Exit Survey. As stated earlier, this survey is given to the firsties at the end of their last semester. In this question, they were asked whether or not they agree with the statement “The program has prepared me to demonstrate knowledge of contemporary issues.” 12/13 cadets replied that they either agreed or strongly agreed, 7/13 replied that they strongly agreed (score = 5/5), and one cadet replied with a “neutral” (score = 3/5). This equates to a mean score of 4.46/5.00 for the 13 cadets. The expected level of attainment on this survey is 4.00/5.00.
4. Contemporary Issues Rubric. The contemporary issues rubric was new for AY14 and was not described in the self study. It is designed to assess performance in four skills associated with the ability to demonstrate knowledge of contemporary issues, namely, determining whether the issue is contemporary, technical competence of the cadet, synthesis of ideas, and communication. The rubrics are completed by the instructors to assess the cadets in specific assignments in the program courses, namely Writing Assignment 4 in CH485 and the Capstone Project in CH364. The results are shown in the rubric below, where we have reported averages for all of the cadets in the courses. The expected levels of attainment are color-coded, with red indicating a need for improvement, and yellow and green indicating that expectations are met or exceeded, respectively.



Your Name: <b>Dr. Biaglow</b>				Cadets Assessed: <b>All first-class chemical engineers (seniors)</b>					
Your Position: <b>CH485 Instructor</b>				Major of Cadets Assessed: <b>Chemical Engineering</b>					
	<b>1 – Needs Improvement</b>	<b>1</b>	<b>2</b>	<b>3 – Meets Expectations</b>	<b>3</b>	<b>4</b>	<b>5 – Exceeds Expectations</b>	<b>5</b>	<b>N/A</b>
<b>Contemporary</b>	Does not address the assignment. Lacks contemporary context. Uses generic arguments or essay lacks specificity.			Discusses contemporary nature of issue but context is weak or implied. Examples are few or lacking.			Uses numerous examples and scholarly articles to illustrate contemporary nature of issue.	<b>4.5 ±.8</b>	
<b>Technical Competence</b>	Demonstrates poor or incomplete understanding of transport phenomena.			Demonstrates some knowledge of the technical content, but explanation lacks depth.		<b>4.2 ±.9</b>	Demonstrates exceptional knowledge of technical content.		
<b>Synthesis of Ideas</b>	Does not connect contemporary issue with concepts in chemical engineering.			Makes connections with chemical engineering concepts, but the connections are weak or implied.		<b>4.4 ±.7</b>	Makes very clear connections between the issue and chemical engineering concepts.		
<b>Communication</b>	Writing lacks organization or cohesion. Numerous grammatical errors that may interfere with meaning. Thesis lacking or implied.			Occasional grammar errors that do not impede meaning. Demonstrates ability to write a basic essay, but lacks cohesion or completeness. Thesis not fully supported.		<b>4.4 ±.5</b>	Demonstrates an ability to effectively communicate in the essay format. Fully supported, clear, concise thesis. Writing style was exceptionally clear and articulate.		
Have the cadets demonstrated knowledge of contemporary issues? <b>Yes</b>	Comments: The rubric scores were used to produce the grades given to the students. The essays were very well-written. Cadets were able to explain relevant transport phenomena and demonstrate that the question and associated issues are contemporary. Raw data and analysis is found in the CH485 grades worksheet. Final Grade: <b>4.4/5</b>						Assignment used for assessment: <b>CH485 Writing Assignment 4</b>		

Your Name: <b>MAJ Gerfen</b>				Cadets Assessed: <b>All second-class chemical engineers (juniors)</b>					
Your Position: <b>CH364 Instructor</b>				Major of Cadets Assessed: <b>Chemical Engineering</b>					
	<b>1 – Needs Improvement</b>	<b>1</b>	<b>2</b>	<b>3 – Meets Expectations</b>	<b>3</b>	<b>4</b>	<b>5 – Exceeds Expectations</b>	<b>5</b>	<b>N/A</b>
<b>Contemporary</b>	Does not address the assignment. Lacks contemporary context. Uses generic arguments or essay lacks specificity.			Discusses contemporary nature of issue but context is weak or implied. Examples are few or lacking.	<b>3.6 ±.6</b>		Uses numerous examples and scholarly articles to illustrate contemporary nature of issue.	<b>3.6 ±.8</b>	
<b>Technical Competence</b>	Demonstrates poor or incomplete understanding of transport phenomena.			Demonstrates some knowledge of the technical content, but explanation lacks depth.	<b>3.8 ±.8</b>	<b>4.2 ±.9</b>	Demonstrates exceptional knowledge of technical content.		
<b>Synthesis of Ideas</b>	Does not connect contemporary issue with concepts in chemical engineering.			Makes connections with chemical engineering concepts, but the connections are weak or implied.	<b>3.7 ±.7</b>		Makes very clear connections between the issue and chemical engineering concepts.		
<b>Communication</b>	Writing lacks organization or cohesion. Numerous grammatical errors that may interfere with meaning. Thesis lacking or implied.			Occasional grammar errors that do not impede meaning. Demonstrates ability to write a basic essay, but lacks cohesion or completeness. Thesis not fully supported.	<b>3.6 ±.7</b>		Demonstrates an ability to effectively communicate in the essay format. Fully supported, clear, concise thesis. Writing style was exceptionally clear and articulate.		
Have the cadets demonstrated knowledge of contemporary issues? <b>Yes</b>	Comments: Each cadet was assessed individually based on observations during the oral report and IPRs, as well as to some extent on the written reports. This assessment was not used as a portion of the grade.  Final Course Average: <b>3.7/5</b>						Assignment used for assessment: <b>CH364 Capstone Project</b>		

### Level of Achievement of Student Outcome 11:

On completion of the chemical engineering program, our graduates will be able to demonstrate an ability to use techniques, skills, and modern engineering tools necessary for engineering practice.

#### *Assessment Instruments and Frequency:*

1. Chemical & Mechanical Engineering Coursework Embedded Indicators, once/yr.
2. Fundamentals of Engineering Examination, once/yr.
3. End of Semester Student Surveys, once/semester.
4. Chemical Engineering Program Exit Survey, once/yr.

#### *Assessment Results:*

1. Chemical & Mechanical Engineering Coursework Embedded Indicators

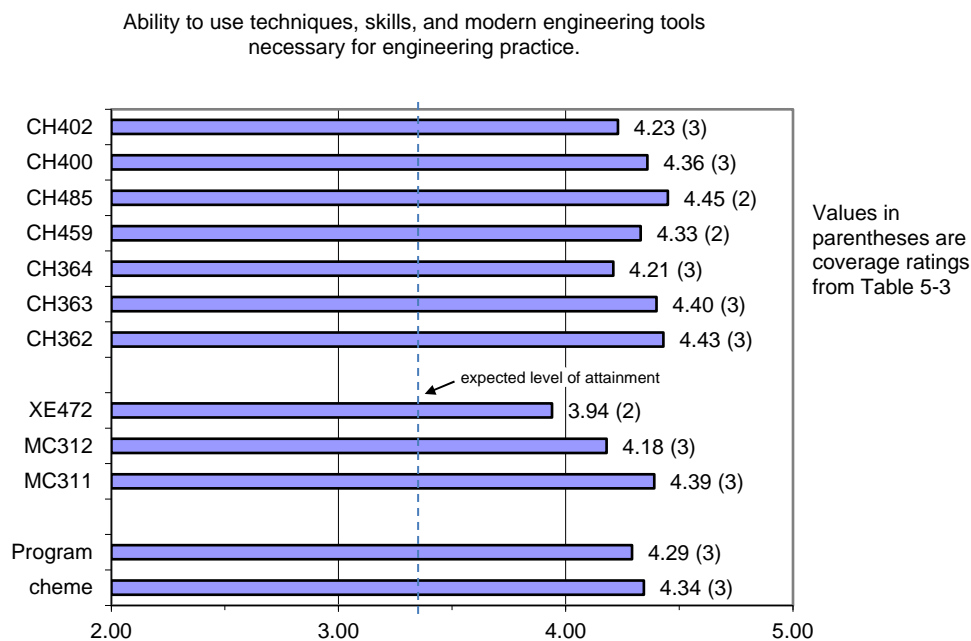


Figure 11-1. Coursework Embedded Indicator results for Student Outcome 11.

2. Fundamentals of Engineering Examination, Table 11-1. **As of AY14, NCEES has decided not to provide this information to non-accredited programs. Sample data is shown below for AY13. We expect this data to re-appear in AY16.**

Time	Subject	Outcome	Questions	USMA %	National % (expected level of attainment)
AM	Computers	11	8	81	82
PM	Computer Usage & Chem. Engineering	11	3	67	68

The national average pass rates of 65 and 76% in these subjects are the metrics used as our expected level of attainment.

### 3. End of Semester Student Surveys

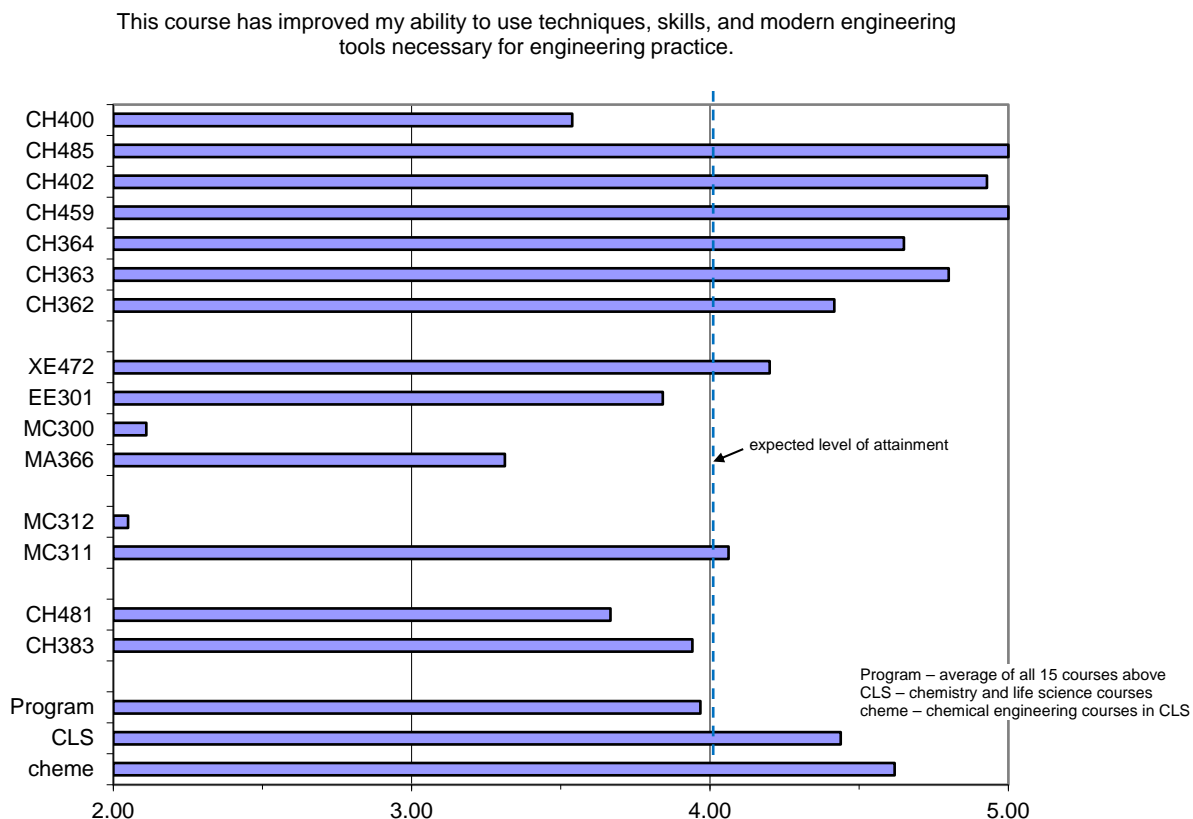


Figure 11-2. End-of-Semester Student Survey responses for Student Outcome 11.

4. Chemical Engineering Program Exit Survey. As stated earlier, this survey is given to the firsties at the end of their last semester. In this question, they were asked whether or not they agree with the statement “The program has prepared me to understand and use techniques, skills, and modern engineering tools necessary for engineering practice.” All 13 cadets replied that they either agreed or strongly agreed, and 11/13 replied that they strongly agreed (score = 5/5). This equates to a mean score of 4.85/5.00 for the 13 cadets. The expected level of attainment on this survey is 4.00/5.00.

**Level of Achievement of Student Outcomes 12-20:**

The program provides the graduate with a thorough grounding and working knowledge of the chemical sciences, including:

12. General, organic, physical, and analytical chemistry.
13. Material and energy balances on chemical processes, including safety and environmental factors.
14. Thermodynamics of physical and chemical equilibria.
15. Heat, mass, and momentum transfer.
16. Chemical reaction engineering.
17. Continuous and staged separation operations.
18. Process dynamics and control.
19. Process design.
20. Modern experimental and computing techniques.

***Assessment Instruments and Frequency:***

1. Fundamentals of Engineering Examination, once/yr.
2. Average Course Grades for Chemical Engineering Students, once/yr.

***Assessment Results:***

1. Fundamentals of Engineering Examination, Table 4-1. **As stated above, AY14 data are unavailable and we expect this data to re-appear in AY16.** For the Class of 2013, 13 of 14 or 93% of the students who took the FEE passed. The breakdown by topic is shown below for USMA (USMA ChE) in comparison to the national averages.

Time	Subject	Outcome	Questions	USMA ChE	National % (expected level of attainment)
AM	Chemistry	12	11	78	79
PM	Chemistry	12	6	72	74
PM	Mass/Energy Balances	13	9	72	73
PM	Safety, Health, Env.	13	3	77	75
AM	Thermodynamics	14	8	72	73
PM	Thermodynamics	14	6	54	59
AM	Fluid Mechanics	15	8	76	72
PM	Fluid Dynamics	15	6	53	57
PM	Heat Transfer	15	6	64	71
PM	Mass Transfer	17	6	42	50
PM	Reaction Engineering	16	6	78	71
PM	Process Control	18	3	67	75
AM	Engineering Economics	20	10	69	65
PM	Process Design	20	6	78	76
AM	Computers	19	8	87	80
PM	Computer Usage & Chem. Engineering	19	3	67	68

2. Course grades for the last six years are shown below, Table 4-2.

Course ↓		ChE Student Outcomes 12-20								
		Advanced Chemistry	Mater. & Energy Bal.	Thermodynamics	Transport	Reaction Engineering	Separations	Dynamics & Control	Process Design	Experiment & Compute
		12	13	14	15	16	17	18	19	20
CH383	Organic Chemistry I	3.05								
CH481	Physical Chemistry I	3.77		3.77						
CH362	Mass & Energy Balances		3.64							
CH363	Separation Processes						3.72			
CH364	Chem. Reaction Eng.					3.28				
CH459	Chem. Eng. Laboratory									3.87
CH485	Heat and Mass Transfer				3.77					
CH400	Chemical Engineering Sem.			3.90		3.90	3.90	3.90		
CH402	Chem. Eng. Process Des.								3.23	
MA366	Vector Calculus									
ME311	Thermal-Fluid Systems I			3.64	3.64					
ME312	Thermal-Fluid Systems II			3.59	3.59					
CE300	Fund. Eng. Mech. & Des.									
EE301	Intro. To Elec. Engineering									
XE472	Dyn. Modeling & Control							3.74		
Average Grade 2014		3.41	3.64	3.72	3.67	3.59	3.81	3.82	3.23	3.87
Average Grade 2013		3.28	3.56	3.51	3.67	3.33	3.38	3.40	3.64	3.59
Average Grade 2012		3.17	3.51	3.38	3.48	3.40	3.39	3.41	3.44	3.64
Average Grade 2011		3.35	3.51	3.37	3.34	3.40	3.26	3.21	3.33	3.41
Average Grade 2010		3.23	3.31	3.38	3.42	3.51	3.41	3.36	3.30	3.31
Average Grade 2009		3.40	3.39	3.31	3.47	3.62	3.54	3.33	3.44	3.82
Previous 5-year Running Average (expected level of attainment)		3.29	3.46	3.39	3.48	3.45	3.40	3.34	3.43	3.55
Standard Deviation 2014		0.66	0.67	0.60	0.52	0.51	0.42	0.48	0.61	0.44

Table 4-3. Faculty Evaluation of Chemical Engineering Student Outcomes

<b>Chemical Engineering Student Outcomes</b>	<b>Faculty Evaluation</b>
On completion of the chemical engineering program, our graduates will be able to:	
1. Apply knowledge of mathematics, science, and engineering.	$4.67 \pm 0.52$
2. Design and conduct experiments, as well as analyze and interpret data.	$4.33 \pm 0.52$
3. Design a system, component, or process to meet desired needs within economic, environmental, social, political, ethical, health and safety, manufacturing, and sustainability constraints.	$4.67 \pm 0.52$
4. Function on multidisciplinary teams.	$4.33 \pm 0.82$
5. Identify, formulate, and solve engineering problems.	$4.67 \pm 0.52$
6. Understand professional and ethical responsibilities.	$4.67 \pm 0.52$
7. Communicate effectively.	$4.50 \pm 0.55$
8. Understand the impact of engineering solutions in a global economic, environmental, and societal context.	$4.67 \pm 0.52$
9. Recognize the need and develop the skills required for life-long learning.	$4.83 \pm 0.41$
10. Demonstrate knowledge of contemporary issues.	$4.67 \pm 0.52$
11. Demonstrate an ability to use techniques, skills, and modern engineering tools necessary for engineering practice.	$4.67 \pm 0.52$
12-20. The program provides the graduate with a thorough grounding and working knowledge of the chemical sciences, including general, organic, and physical chemistry; material and energy balances on chemical processes, including safety and environmental factors; thermodynamics of physical and chemical equilibria; heat, mass, and momentum transfer; chemical reaction engineering; continuous and staged separation operations; process dynamics and control; process design; and modern experimental and computing techniques.	$4.17 \pm 0.41$
<b>5- Excellent; 4 – Very Good; 3 – Acceptable; 2 – Weak ; 1 – Poor</b>	

Table 4-4. Advisory Board Evaluation of Chemical Engineering Student Outcomes

<b>Chemical Engineering Student Outcomes</b>	<b>Advisory Board's Evaluation</b>
On completion of the chemical engineering program, our graduates will be able to:	
1. Apply knowledge of mathematics, science, and engineering.	5.00 $\pm$ 0.00
2. Design and conduct experiments, as well as analyze and interpret data.	4.43 $\pm$ 0.79
3. Design a system, component, or process to meet desired needs within economic, environmental, social, political, ethical, health and safety, manufacturing, and sustainability constraints.	4.57 $\pm$ 0.53
4. Function on multidisciplinary teams.	4.71 $\pm$ 0.49
5. Identify, formulate, and solve engineering problems.	4.86 $\pm$ 0.38
6. Understand professional and ethical responsibilities.	4.43 $\pm$ 0.79
7. Communicate effectively.	4.86 $\pm$ 0.38
8. Understand the impact of engineering solutions in a global economic, environmental, and societal context.	4.29 $\pm$ 0.76
9. Recognize the need and develop the skills required for life-long learning.	4.57 $\pm$ 0.53
10. Demonstrate knowledge of contemporary issues.	4.14 $\pm$ 0.69
11. Demonstrate an ability to use techniques, skills, and modern engineering tools necessary for engineering practice.	4.71 $\pm$ 0.49
12-20. The program provides the graduate with a thorough grounding and working knowledge of the chemical sciences, including general, organic, and physical chemistry; material and energy balances on chemical processes, including safety and environmental factors; thermodynamics of physical and chemical equilibria; heat, mass, and momentum transfer; chemical reaction engineering; continuous and staged separation operations; process dynamics and control; process design; and modern experimental and computing techniques.	4.43 $\pm$ 0.79
<b>5- Excellent; 4 – Very Good; 3 – Acceptable; 2 – Weak ; 1 – Poor</b>	

Table 4-5. Summary of Chemical Engineering Student Outcomes Performance.

Chemical Engineering Student Outcomes	Program Director's Summary
On completion of the chemical engineering program, our graduates will be able to:	
1. Apply knowledge of mathematics, science, and engineering.	5
2. Design and conduct experiments, as well as analyze and interpret data.	5
3. Design a system, component, or process to meet desired needs within economic, environmental, social, political, ethical, health and safety, manufacturing, and sustainability constraints.	5
4. Function on multidisciplinary teams.	5
5. Identify, formulate, and solve engineering problems.	5
6. Understand professional and ethical responsibilities.	5
7. Communicate effectively.	5
8. Understand the impact of engineering solutions in a global economic, environmental, and societal context.	5
9. Recognize the need and develop the skills required for life-long learning.	5
10. Demonstrate knowledge of contemporary issues.	5
11. Demonstrate an ability to use techniques, skills, and modern engineering tools necessary for engineering practice.	5
12-20. The program provides the graduate with a thorough grounding and working knowledge of the chemical sciences, including general, organic, and physical chemistry; material and energy balances on chemical processes, including safety and environmental factors; thermodynamics of physical and chemical equilibria; heat, mass, and momentum transfer; chemical reaction engineering; continuous and staged separation operations; process dynamics and control; process design; and modern experimental and computing techniques.	5
5- Excellent; 4 – Very Good; 3 – Acceptable; 2 – Weak ; 1 – Poor	