

PROGRAM ASSESSMENT DATA AY2014-2015

UNITED STATES MILITARY ACADEMY
DEPARTMENT OF CHEMISTRY AND LIFE SCIENCE
CHEMICAL ENGINEERING PROGRAM
April 12, 2016

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Note: This data is intended to allow completion of the faculty and advisory board surveys. Faculty and advisory board members review the data first and then complete 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

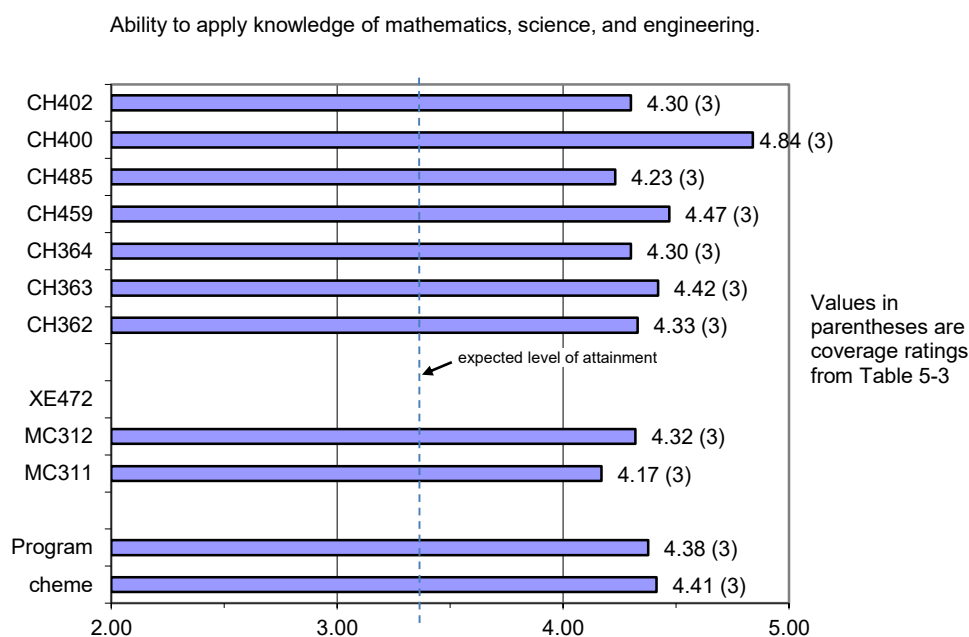


Figure 1-1. Coursework Embedded Indicator results for Student Outcome 1.

2. Fundamentals of Engineering Examination (FEE). According to the 2015 report from NCEES, 16 out of 21, or 76%, of the students in the Class of 2015 took and passed the FE Exam. Historically, this compares to 2014 (93%), 2013 (93%), 2012 (92%), 2011 (81%), and 2010 (100%). Our five-year running average is 91.8% with a standard deviation of 6.8% over the previous five years. The national average pass rate in 2015 was 77%, and this is our expected level of attainment.

Note: At the national level, the percentage of chemical engineers passing the exam was 86% for many years prior to 2015. As of this year, NCEES changed the comparator group that they report to USMA to those taking the exam within 12 months prior to graduation. Also, a new chemical engineering exam was

implemented this year. As a result of these changes, the national average reported to USMA dropped to 77%, which is our new expected level of attainment.

3. End of Semester Student Surveys

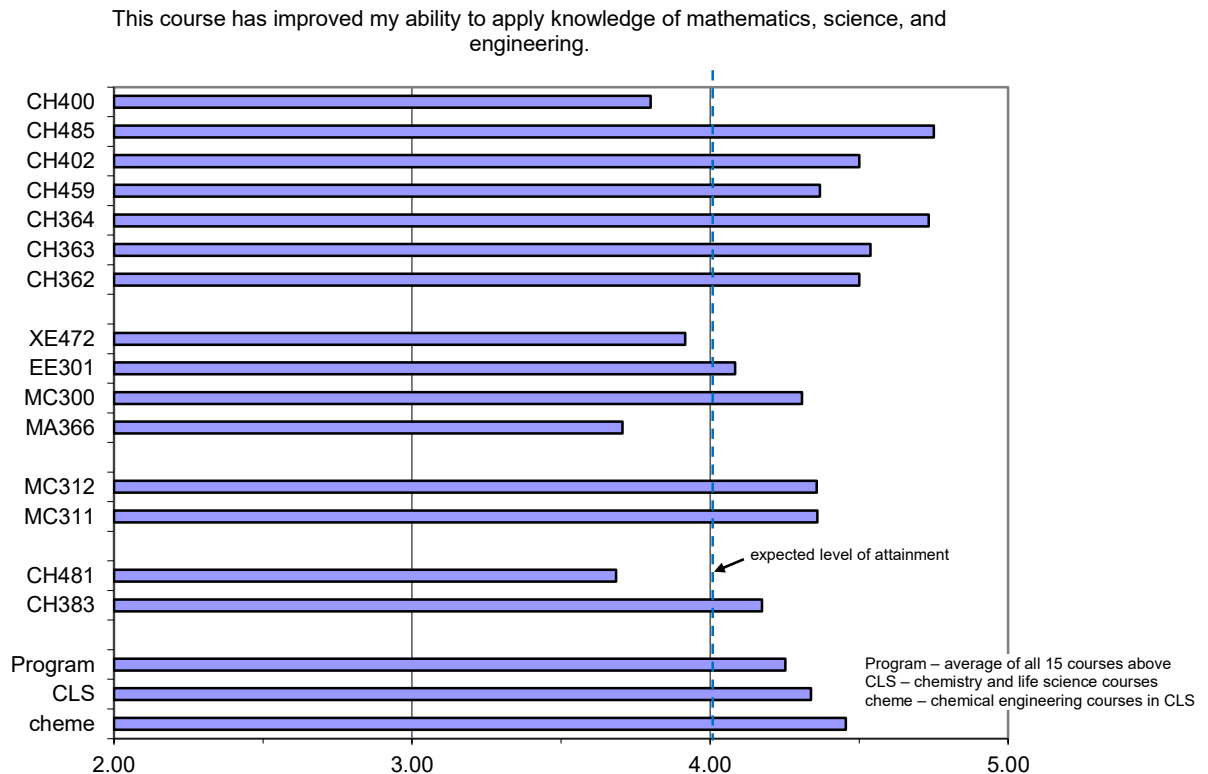


Figure 1-2. End-of-Semester Student Survey responses for Student Outcome 1.

4. Chemical Engineering Program Exit Survey. This survey is given to 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 21 cadets replied that they agreed or strongly agreed, with a mean score of 4.54/5.00 for the 21 cadets. 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

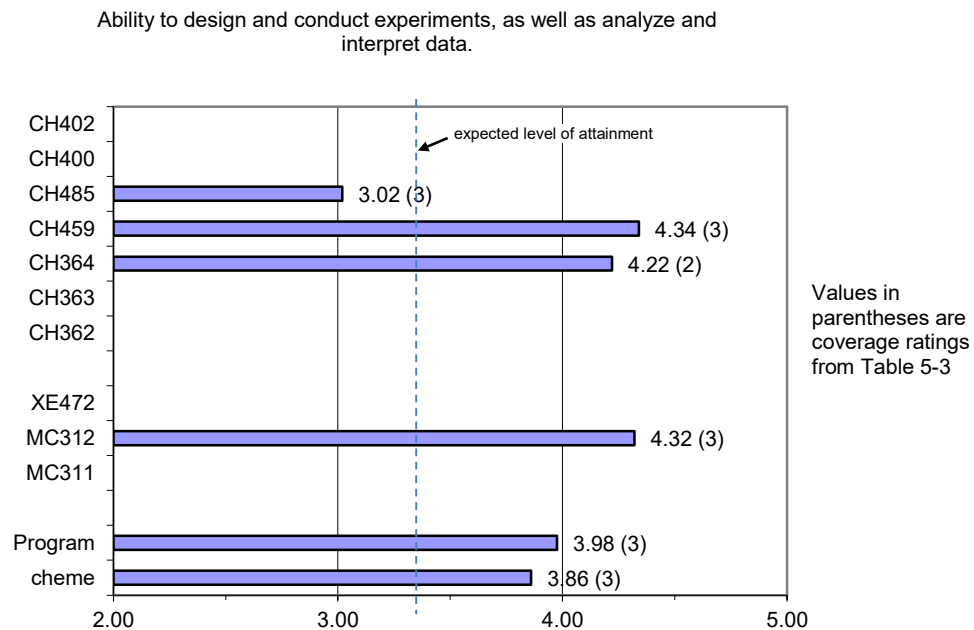


Figure 2-1. Coursework Embedded Indicator results for Student Outcome 2.

2. End of Semester Student Surveys

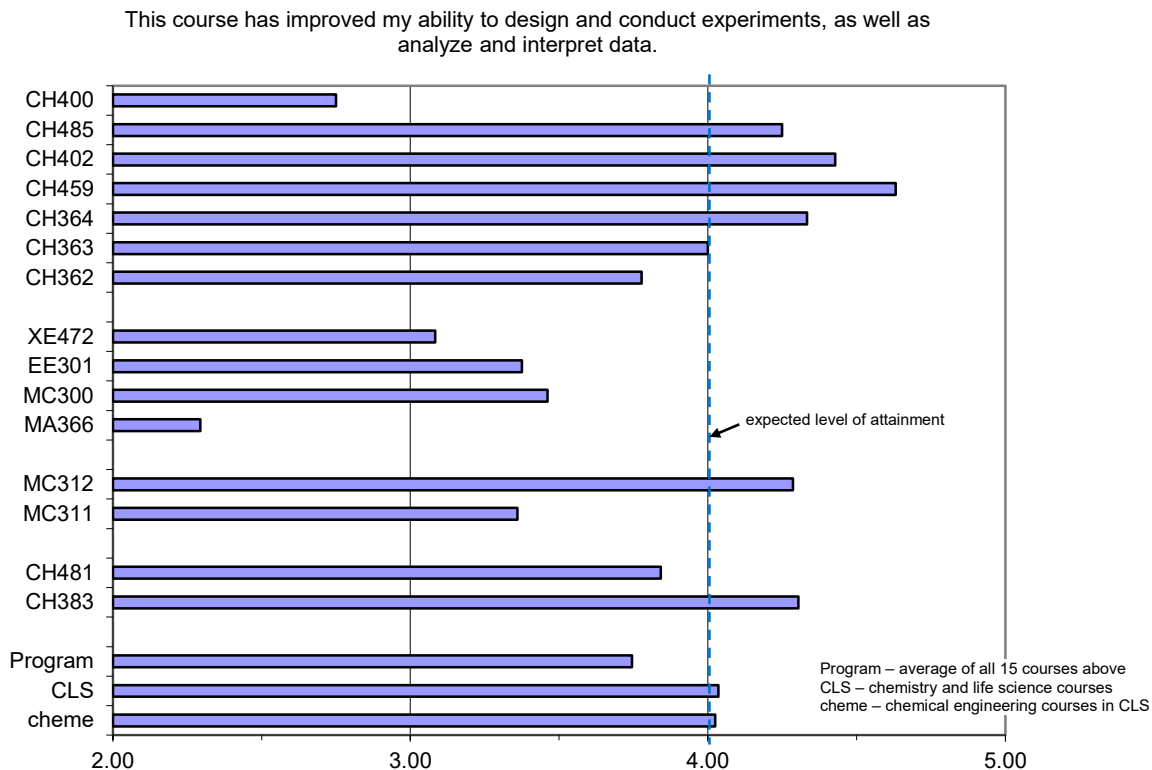


Figure 2-2. End-of-Semester Student Survey responses for Student Outcome 2.

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 21 cadets replied that they either agreed or strongly agreed, and the mean score was 4.44/5.00 for the 21 cadets. The expected level of attainment on the survey is 4.00/5.00.
4. The average course grade in CH459 Chemical Engineering Laboratory was 3.67 ± 0.37 ($n=20$) in AY15, compared to 3.87 ± 0.44 ($n=13$) in AY14, 3.59 ± 0.47 ($n=14$) for AY13, 3.64 ± 0.40 ($n=13$) for AY12, 3.41 ± 0.34 ($n=16$) for AY11, and 3.26 ± 0.69 ($n=13$) for AY10. There were no failures over the last six 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 0.12 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

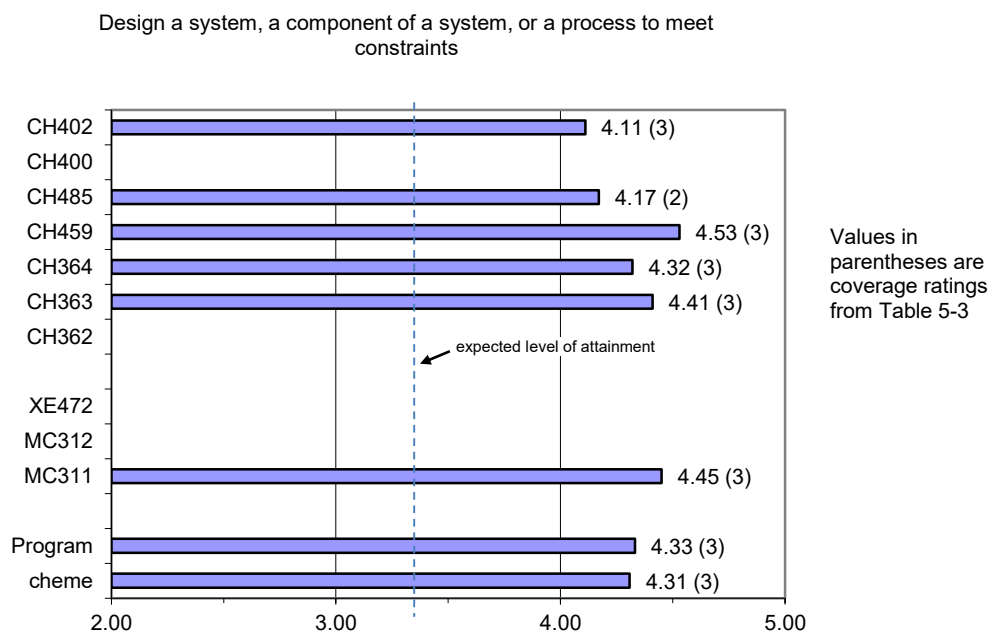


Figure 3-1. Coursework Embedded Indicator results for Student Outcome 3.

2. End of Semester Student Surveys

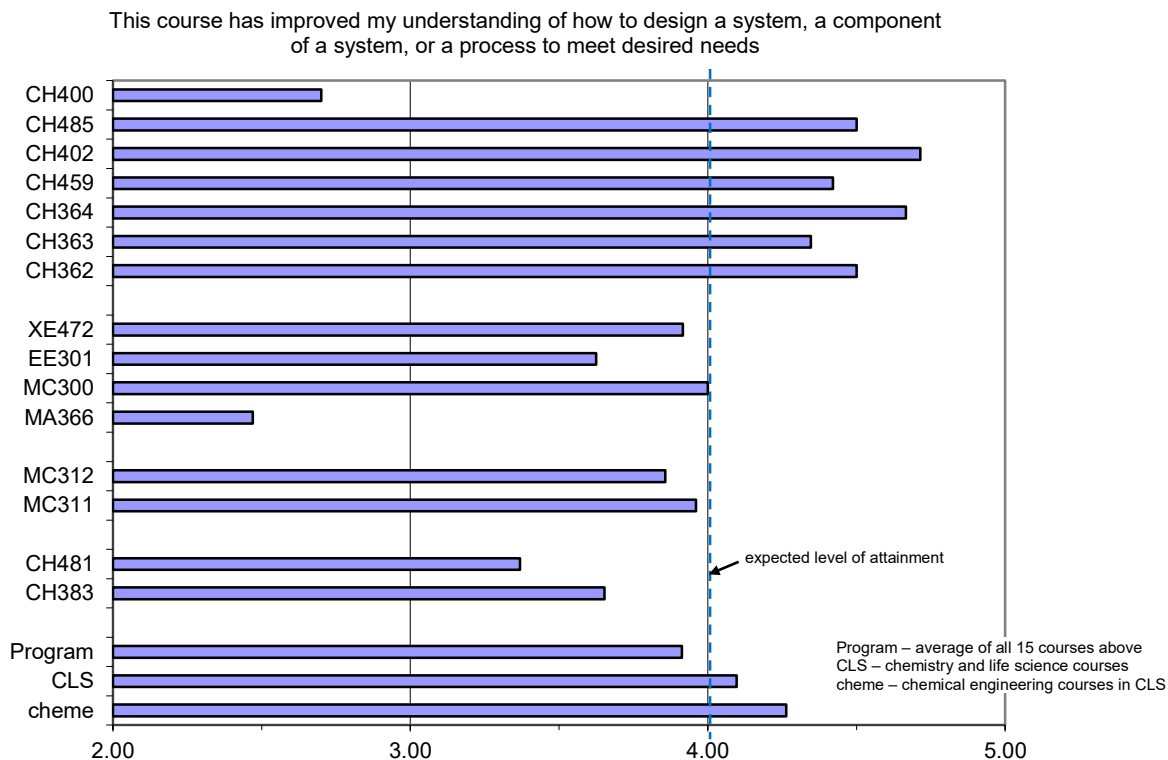


Figure 3-2. End-of-Semester Student Survey responses for Student Outcome 3.

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 cadets replied that they either agreed or strongly agreed, for a mean score of 4.55/5.00 for the 21 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 3.40 ± 0.75 ($n=20$) in AY15, compared to 3.23 ± 0.71 ($n=13$) for AY14, 3.64 ± 0.55 ($n=14$) for AY13, 3.69 ± 0.50 for AY12, 3.33 ± 0.69 ($n=16$) for AY11, and 3.26 ± 0.69 ($n=13$) for AY10. There were no failures over the last six 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 0.03 below the five year running average. Although this number is below the 5-year running average, it is statistically indistinguishable.*

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

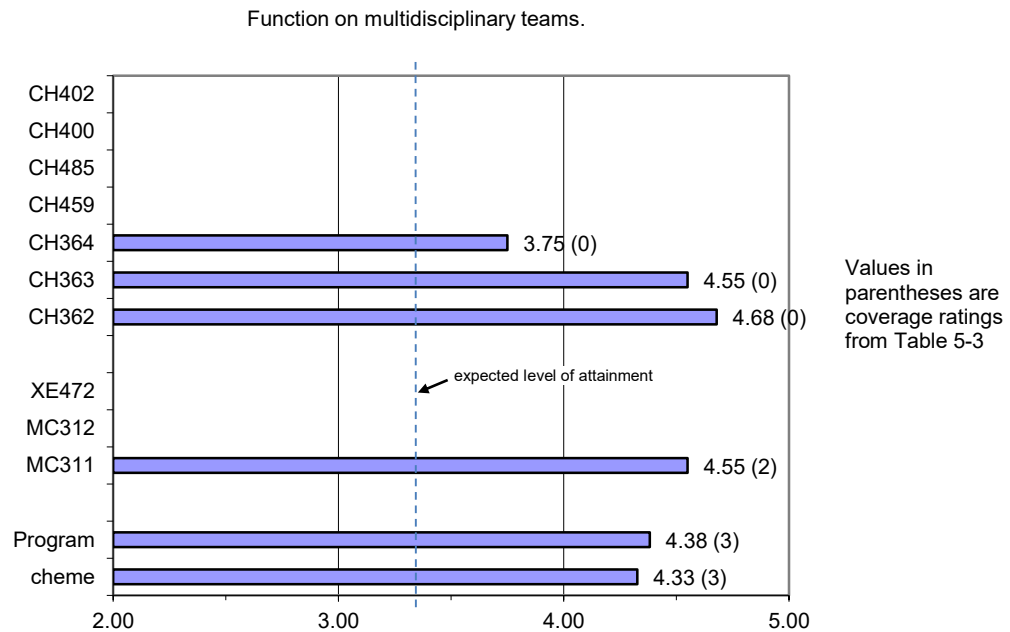


Figure 4-1. Coursework Embedded Indicator results for Student Outcome 4.

2. End of Semester Student Surveys

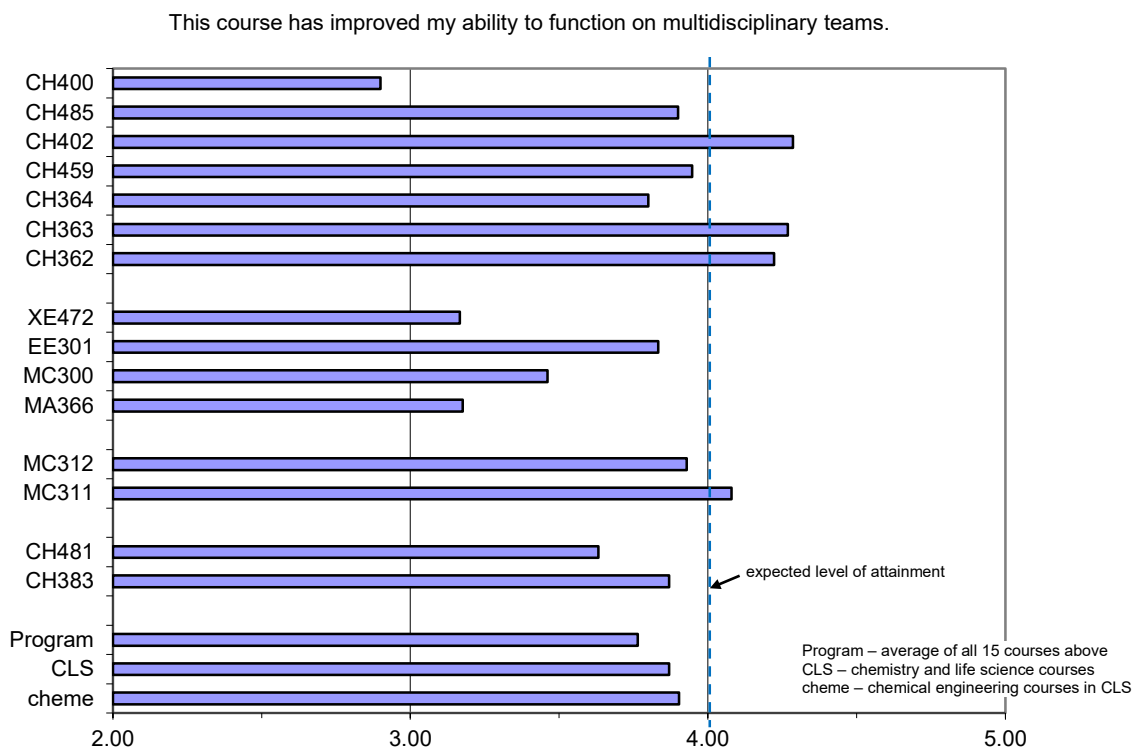


Figure 4-2. End-of-Semester Student Survey responses for Student Outcome 4.

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 21 cadets replied that they either neutral, agreed or strongly agreed, and the mean score was 4.04/5.00 for the 21 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 attributes 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 leaders. The team leaders are asked for a self-assessment. 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 leaders (Group Leader Assessment or GLA). 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.

Your Name: Belanger				Person Assessed: All Cadets in CH459					
Program: 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.		4.1 ^a 4.3 ^b	Exceptional knowledge of technical content.		
Communication	Lacked sensitivity and/or did not provide specific suggestions for improvement.			Effectively communicated important points.		4.1 ^a	Exceptional ability to explain important points. Very effectively communicated ideas for improvement.	4.7 ^b	
Organization	Was not prepared or did not give sufficient time to prepare.			Demonstrated effective organization during class.		4.0 ^a	Was exceptionally efficient, timely and responsive throughout the entire process.	4.9 ^b	
Teamwork	Demonstrated limited ability to see other perspectives or find common ground.			Worked collaboratively with team members to reach consensus.		4.4 ^a	Exceptional ability to help group find common ground or resolve conflict in order to ultimately reach consensus.	4.7 ^b	
Are the cadets capable of functioning on multidisciplinary teams? Yes									
Comments: There were a total of 2 individual assessments in this course. 12/21 of the cadets were group leader twice. Footnote “a” designates the average of all Group Leader Assessment (GLA) scores, while “b” designates average of all Leader Self Assessment (LSA) scores. The standard deviations ranged from 0.4 to 0.8, with an average of 0.71±0.43									

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

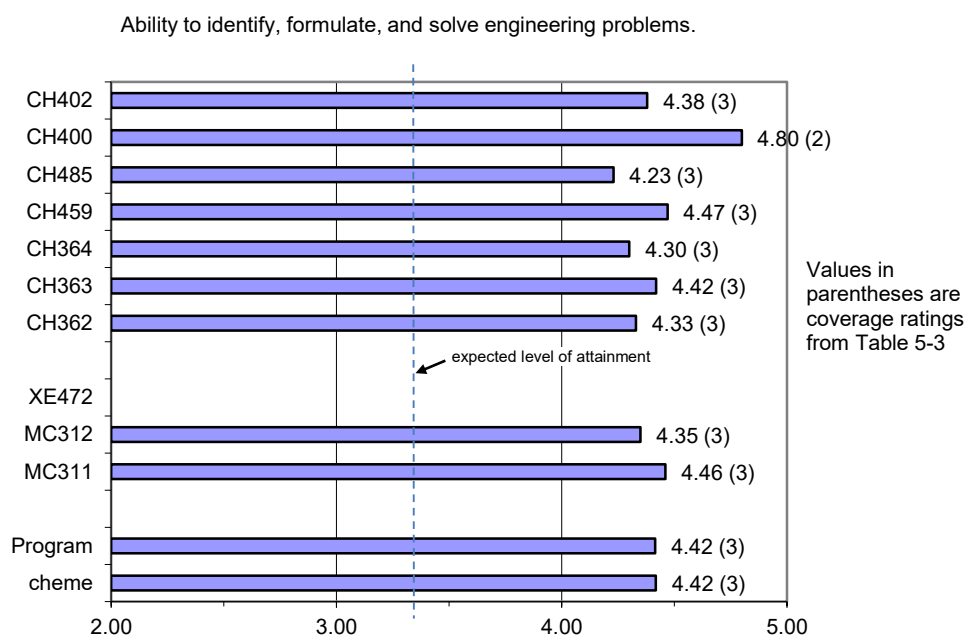


Figure 5-1. Coursework Embedded Indicator results for Student Outcome 5.

2. Fundamentals of Engineering Examination (FEE). According to the 2015 report from NCEES, 16 out of 21, or 76%, of the students in the Class of 2015 took and passed the FE Exam. Historically, this compares to 2014 (93%), 2013 (93%), 2012 (92%), 2011 (81%), and 2010 (100%). Our five-year running average is 91.8% with a standard deviation of 6.8% over the previous five years. The national average pass rate in 2015 was 77%, and this is our expected level of attainment.

Note: At the national level, the percentage of chemical engineers passing the exam was 86% for many years prior to 2015. As of this year, NCEES changed the comparator group that they report to USMA to those taking the exam within 12 months prior to graduation. Also, a new chemical engineering exam was implemented this year. As a result of these changes, the national average reported to USMA dropped to 77%, which is our new expected level of attainment.

3. End of Semester Student Surveys

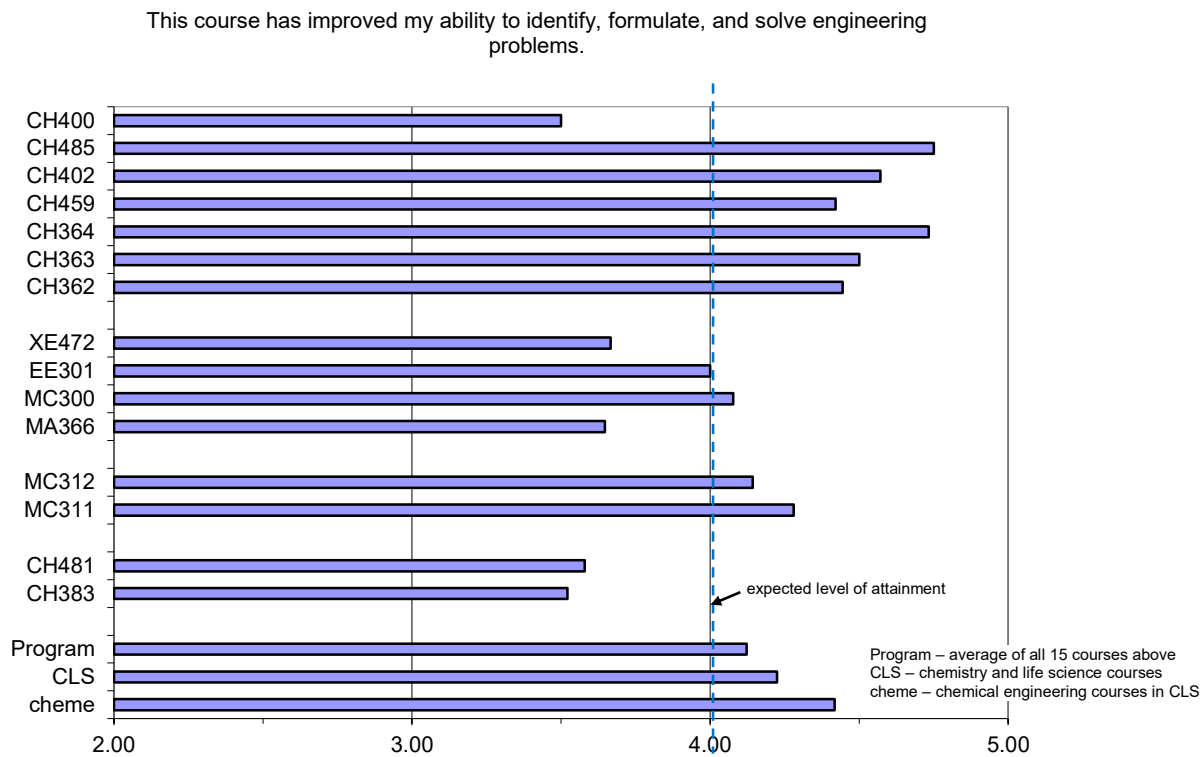


Figure 5-2. End-of-Semester Student Survey responses for Student Outcome 5.

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 21 cadets replied that they either agreed or strongly agreed, and the mean score was 4.58/5.00 for the 21 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

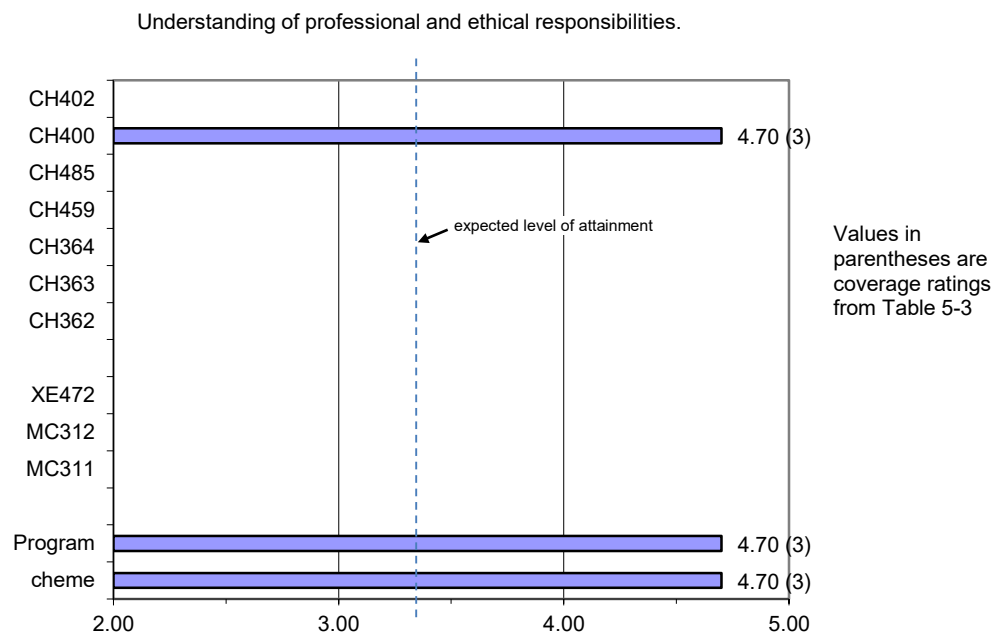


Figure 6-1. Coursework Embedded Indicator results for Student Outcome 6.

2. Fundamentals of Engineering Examination, Table 6-1.

Subject	USMA PI	ABET PI (expected level of attainment)	ABET PI S.D. (expected level of attainment)
Ethics and Business Practices	11.2	11.1	5.4

Performance Index (PI): As of this year, NCEES changed the manner in which it reports scores in subject areas. They now convert the score to a scale of 0-15, and they define this score as the performance index. NCEES also changed the comparator group that they report to USMA. They still report results for our institution, but for a comparison, they now report the results for students at other

institutions who took the exam within 12 months prior to graduation, and they define this as the ABET comparator. The ABET comparator performance index (PI) is now our expected level of attainment.

3. End of Semester Student Surveys

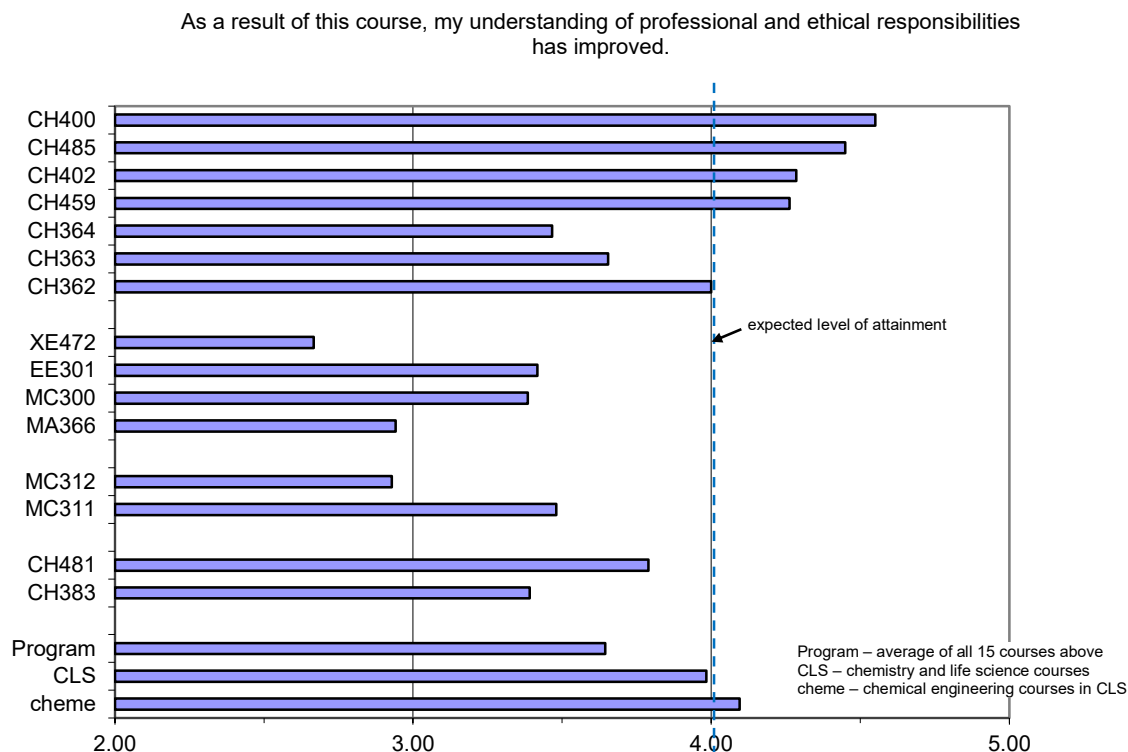


Figure 6-2. End-of-Semester Student Survey responses for Student Outcome 6.

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 21 cadets replied that they either agreed or strongly agreed, the mean score was 4.46/5.00 for the 21 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 21 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

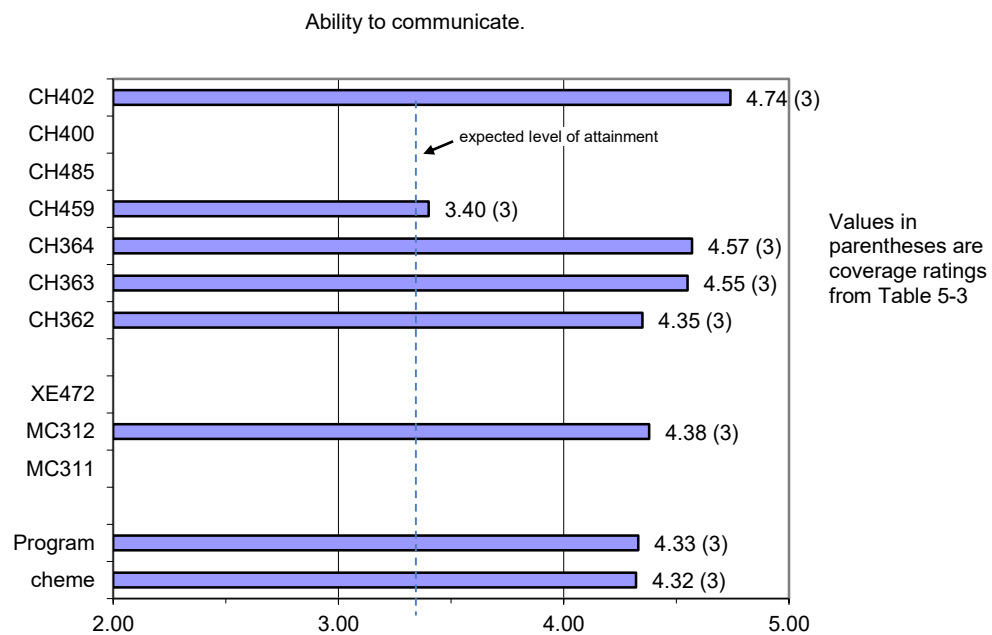


Figure 7-1. Coursework Embedded Indicator results for Student Outcome 7.

2. End of Semester Student Surveys

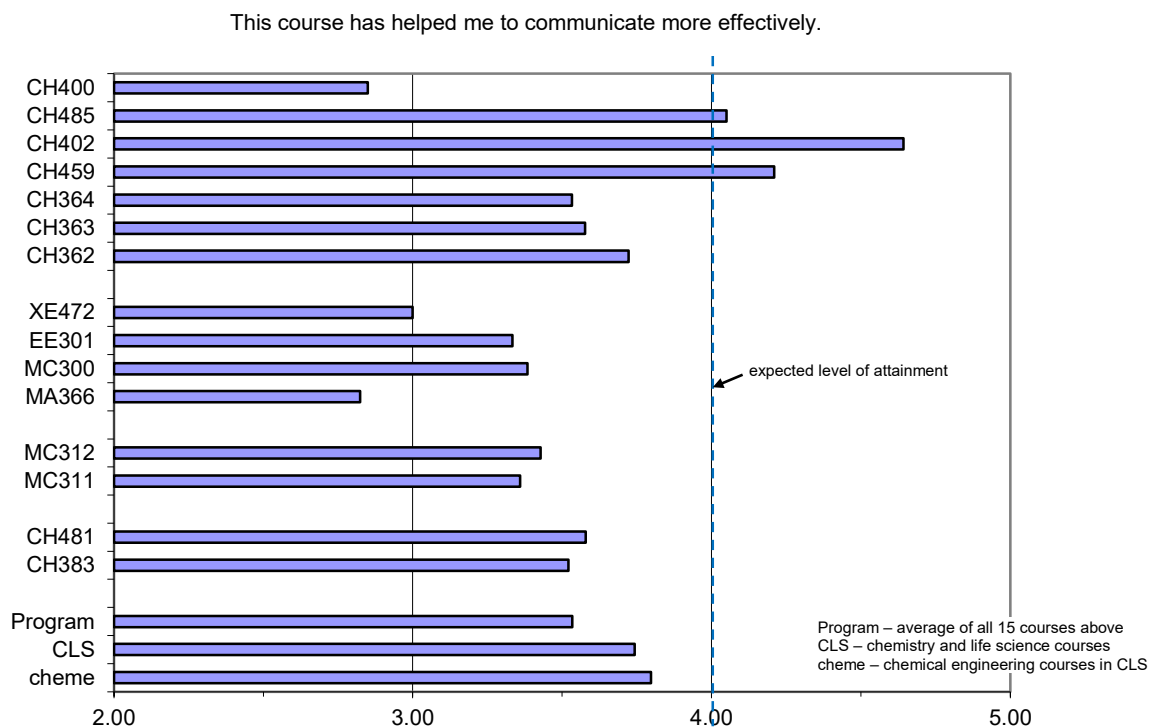


Figure 7-2. End-of-Semester Student Survey responses for Student Outcome 7.

3. The average course grade in CH459 Chemical Engineering Laboratory was 3.67 ± 0.37 ($n=20$) in AY15, compared to 3.87 ± 0.44 ($n=13$) in AY14, 3.59 ± 0.47 ($n=14$) for AY13, 3.64 ± 0.40 ($n=13$) for AY12, 3.41 ± 0.34 ($n=16$) for AY11, and 3.26 ± 0.69 ($n=13$) for AY10. There were no failures over the last six 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 0.12 above the five year running average.*
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 communicate effectively." All cadets replied that they either agreed or strongly agreed, and one cadet replied with a "neutral" (score = 3/5). This equates to a mean score of 4.30/5.00 for the 21 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

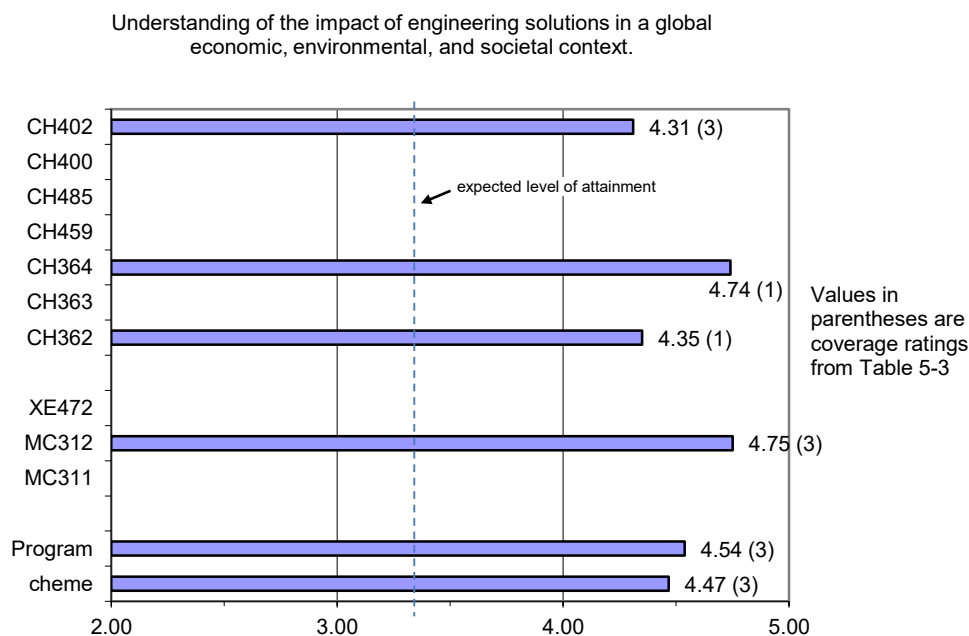


Figure 8-1. Coursework Embedded Indicator results for Student Outcome 8.

2. Fundamentals of Engineering Examination, Table 8-1.

Subject	USMA PI	ABET PI (expected level of attainment)	ABET PI S.D. (expected level of attainment)
Process Design and Economics	9.7	9.5	2.8

Performance Index (PI): As of this year, NCEES changed the manner in which it reports scores in subject areas. They now converts the score to a scale of 0-15, and they define this score as the performance index. NCEES also changed the comparator group that they report to USMA. They still report results for our institution, but for a comparison, they now report the results for students at other institutions who took the exam within 12 months prior to graduation, and they

define this as the ABET comparator. The ABET comparator performance index (PI) is now our expected level of attainment.

3. End of Semester Student Surveys

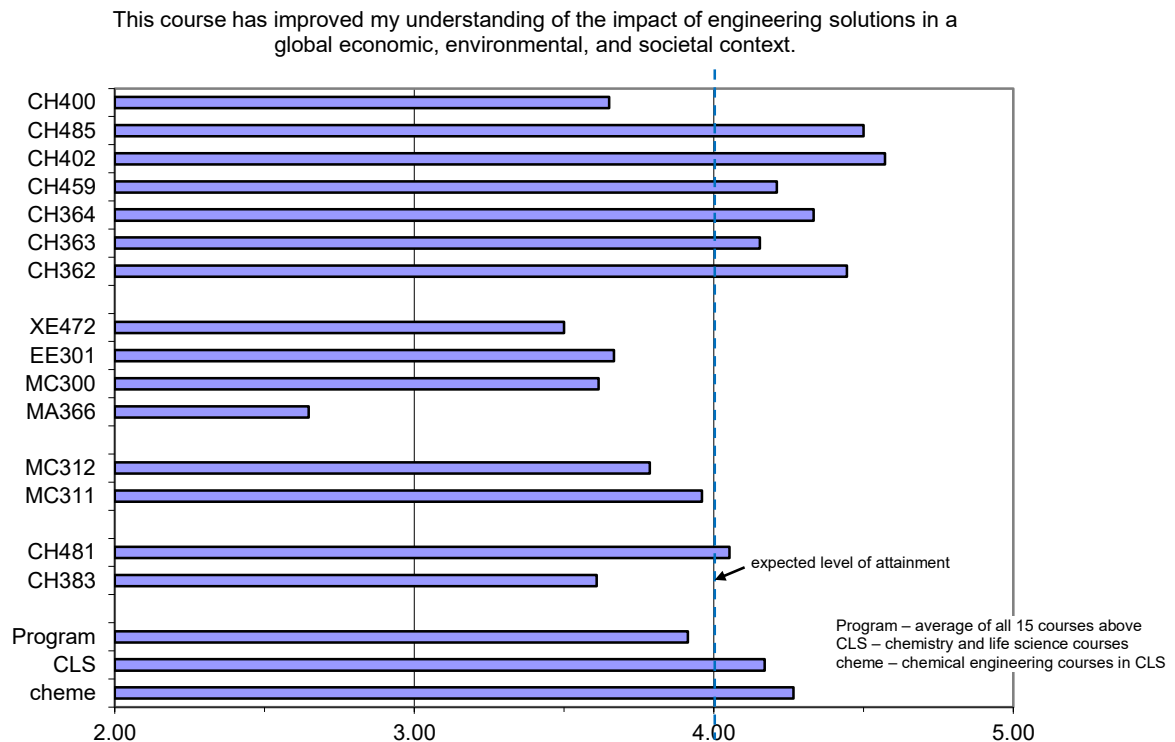


Figure 8-2. End-of-Semester Student Survey responses for Student Outcome 8.

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.” Most of the cadets replied that they either agreed or strongly agreed and one cadet replied with a “neutral” (score = 3/5). This equates to a mean score of 4.43/5.00 for the 21 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

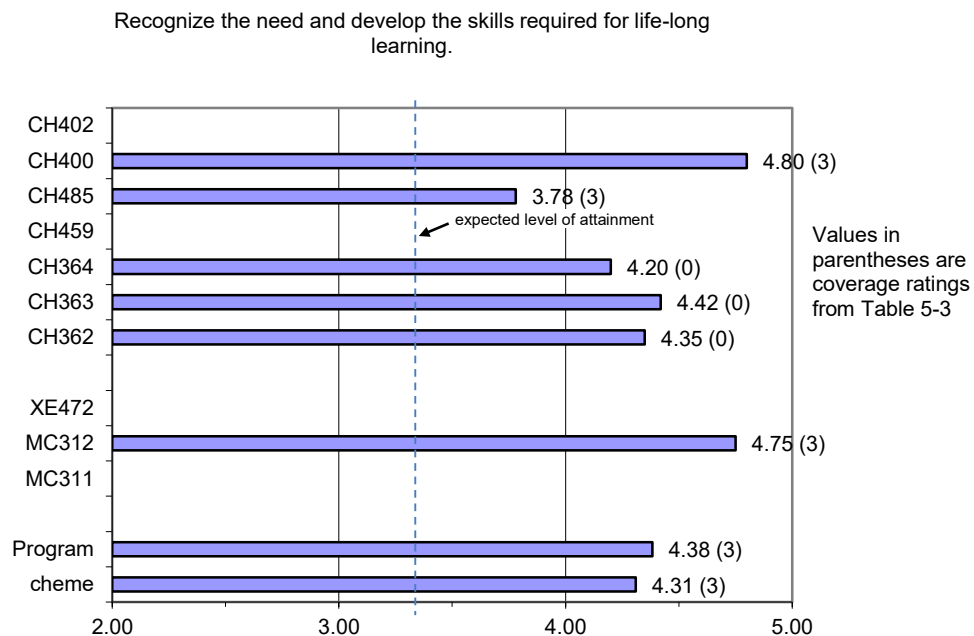


Figure 9-1. Coursework Embedded Indicator results for Student Outcome 9.

2. Percent of Eligible Cadets taking the Fundamentals of Engineering Examination (FEE). For the Class of 2015, there were 21 chemical engineering cadets (100% of the eligible cadets) who prepared for and took the FEE. This compares to 100% in 2014, 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, about 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 for this metric is 100%.

3. End of Semester Student Surveys

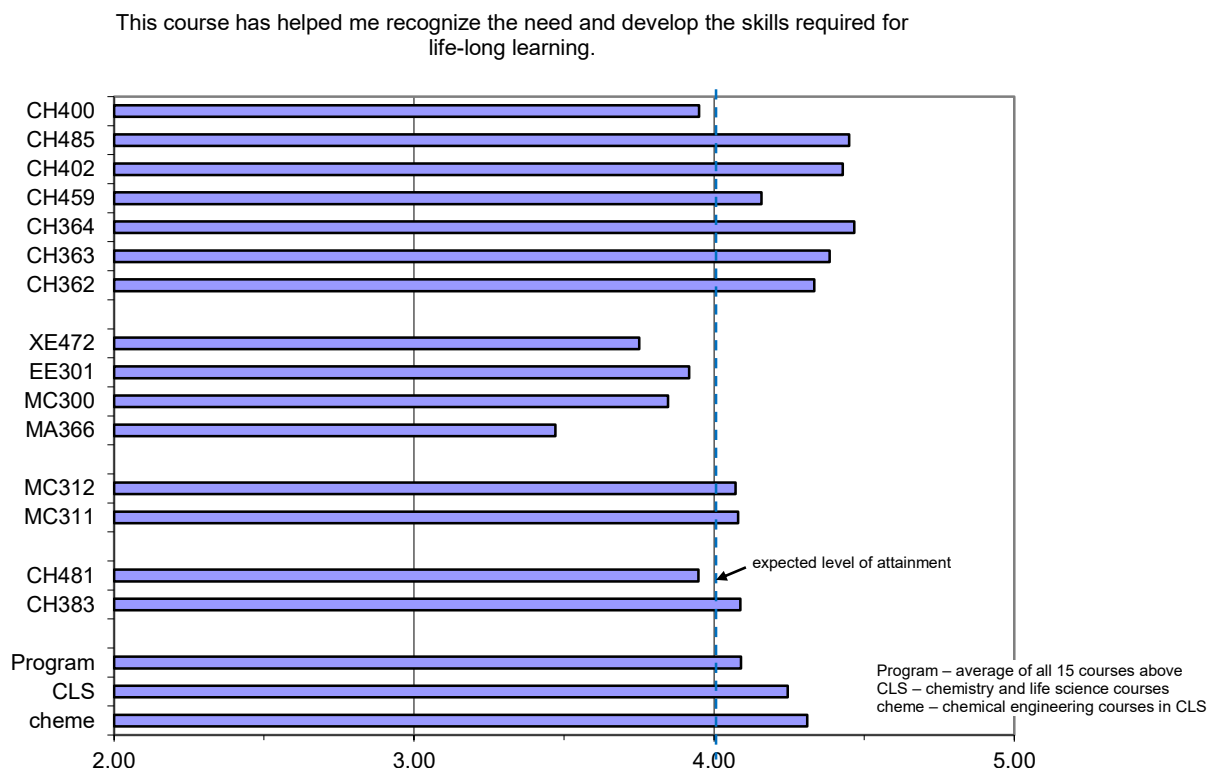


Figure 9-2. End-of-Semester Student Survey responses for Student Outcome 9.

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 21 cadets replied that they either agreed or strongly agreed, for a mean score of 4.35/5.00 for the 21 cadets. The expected level of attainment on this survey is 4.00/5.00.
5. Lifelong Learning Skills Rubric (LLSR). The LLSR, first introduced in AY14, is designed to assess performance in four areas associated with recognizing the need and developing the skills required for life-long learning. These areas are 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 in a resume format. The rubric is used to assign grades specific assignments, namely Writing Assignments 1 and 4 in CH485. Writing Assignment 1 took place near the beginning of the semester, and Writing Assignment 4 took place near the end. The results are shown in the two rubrics below, where the cadet average scores are reported in the rubric entries. 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.

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

Your Name: Biaglow				Cadet Assessed: All first-class chemical engineers (seniors)				
Your Position: Professor, CH485				Major of Cadet Assessed: Chemical Engineering				
	1 – Needs Improvement	1	2	3 – Meets Expectations	3	4	5 – Exceeds Expectations	5 N/A
Engagement	No evidence of pre-professional activities.			References pre-professional activities are lacking or connections to chemical engineering are weak or implied.	3.7 ±1.0		Uses examples of pre-professional chemical engineering activities.	
Recognition	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.		4.1 ±1.3	Identifies specific skills learned in chemical engineering courses.	
Intellectual Growth	Unable to identify new concepts learned this semester.	1.0 ±0.0		Changes are apparent in document, but connections to recent activities in chemical engineering are weak or implied.			Addition of multiple skills acquired this semester.	
Communication	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.	3.5 ±1.1		Demonstrates an ability to effectively communicate in the resume format. Clear, concise content. Resume is interesting.	
Have these cadets achieved this outcome? (Y/N) No.				Comments: In general, cadets did not understand that skills are an important part of the resume writing process, and they did not understand how to identify their own personal skill set. Final Grade: 3.1/5 = 61%			Assignment used for assessment: CH485 Writing Assignment 1 - Resumes	

Your Name: Biaglow				Cadet Assessed: All first-class chemical engineers (seniors)				
Your Position: Professor, CH485				Major of Cadet Assessed: Chemical Engineering				
	1 – Needs Improvement	1	2	3 – Meets Expectations	3	4	5 – Exceeds Expectations	5 N/A
Engagement	No evidence of pre-professional activities.			References pre-professional activities are lacking or connections to chemical engineering are weak or implied.			Uses examples of pre-professional chemical engineering activities.	4.6 ±0.8
Recognition	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.	4.8 ±0.5
Intellectual Growth	Unable to identify new concepts learned this semester.	1.0 ±0.0		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 ±0.6
Communication	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.		4.2 ±0.5	Demonstrates an ability to effectively communicate in the resume format. Clear, concise content. Resume is interesting.	
Have these cadets achieved this outcome? (Y/N) Yes				Comments: Cadets showed improvements in all areas. Group discussion of skills, with examples of good and bad resumes, seemed to have helped. Final Grade: 4.6/5 = 91%			Assignment used for assessment: CH485 Writing Assignment 4 - 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

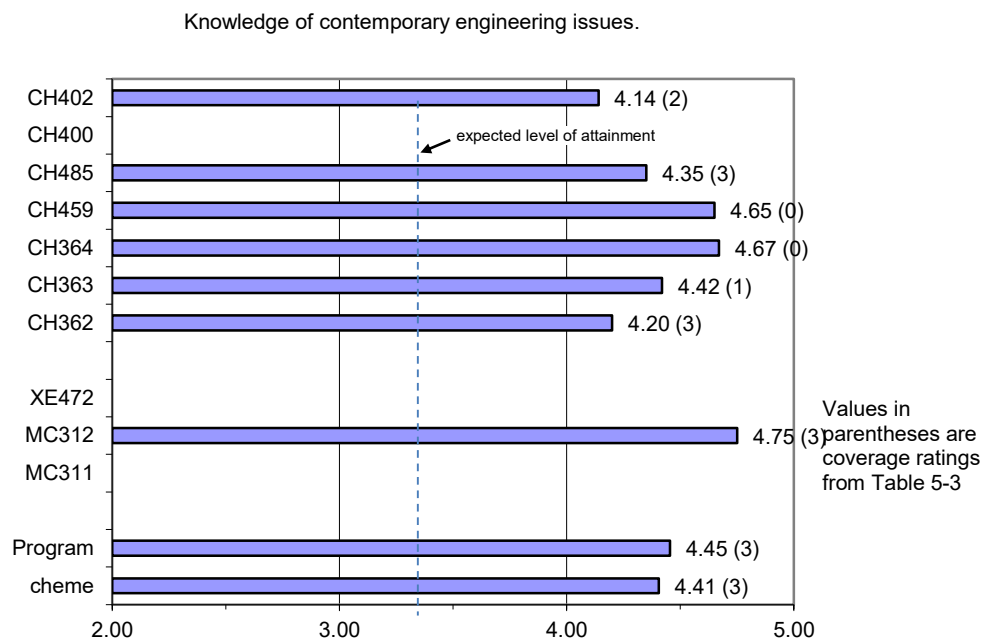


Figure 10-1. Coursework Embedded Indicator results for Student Outcome 10.

2. End of Semester Student Surveys

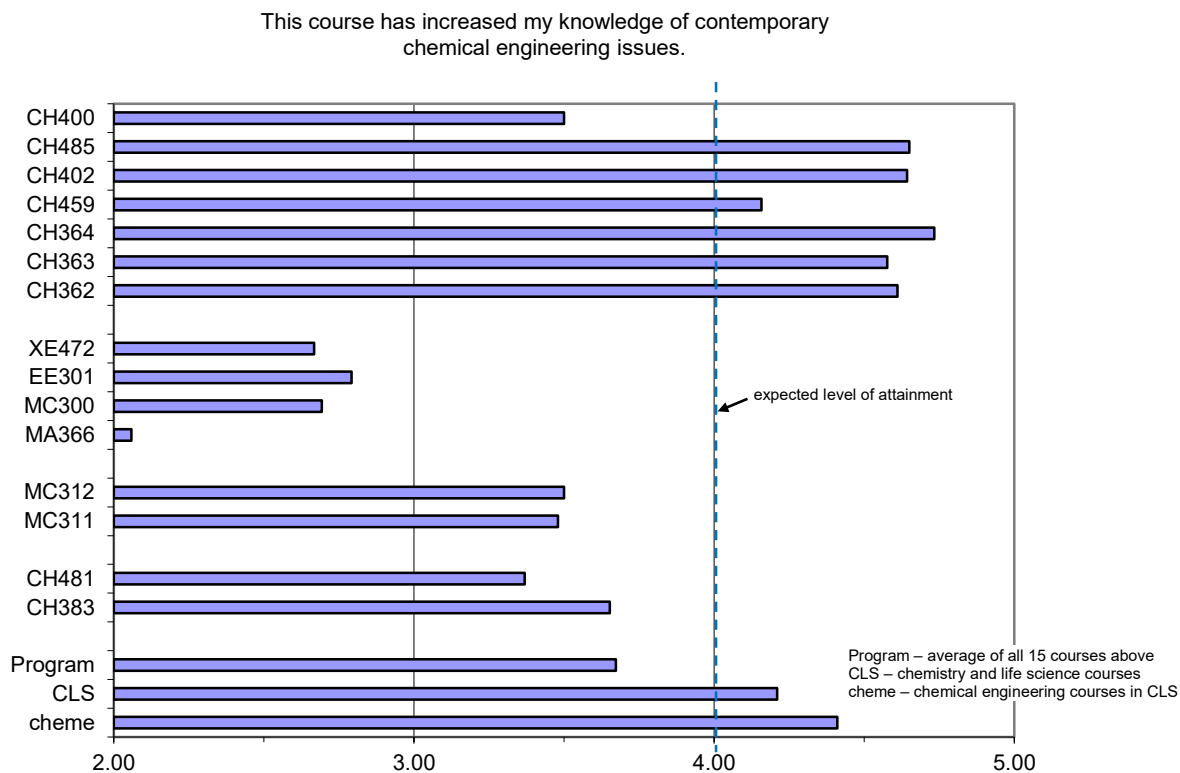


Figure 10-2. End-of-Semester Student Survey responses for Student Outcome 10.

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.” Most cadets replied that they either agreed or strongly agreed, and two cadets replied with a “neutral” (score = 3/5). This equates to a mean score of 4.48/5.00 for the 21 cadets. The expected level of attainment on this survey is 4.00/5.00.
4. Contemporary Issues Rubric. The contemporary issues rubric (CIR), introduced in AY14, is designed to assess performance in four skills associated with the ability to demonstrate knowledge of contemporary issues, namely, determining whether or not the issue is contemporary, the technical competence of the cadet, synthesis of ideas, and communication. The rubrics are completed by the instructors to assign grades to the cadets in specific assignments in the program courses, namely, two writing assignments in CH485 and an oral briefing in 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: Dr. Biaglow				Cadets Assessed: All first-class chemical engineers (seniors)					
Your Position: CH485 Instructor				Major of Cadets Assessed: Chemical Engineering					
	1 – Needs Improvement	1	2	3 – Meets Expectations	3	4	5 – Exceeds Expectations	5	N/A
Contemporary	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.		4.3 ±.6	Uses numerous examples and scholarly articles to illustrate contemporary nature of issue.		
Technical Competence	Demonstrates poor or incomplete understanding of transport phenomena.			Demonstrates some knowledge of the technical content, but explanation lacks depth.		4.0 ±.7	Demonstrates exceptional knowledge of technical content.		
Synthesis of Ideas	Does not connect contemporary issue with concepts in chemical engineering.			Makes connections with chemical engineering concepts, but the connections are weak or implied.		4.1 ±.8	Makes very clear connections between the issue and chemical engineering concepts.		
Communication	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.		4.4 ±.7	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? Yes	Comments: The rubrics were used to produce the grades given to the students. Generally, the essays were fair, and the group as a whole possesses strong writing skills. Cadets were a little shaky on explaining relevant transport phenomena, as well as connecting the ideas to chemical engineering. Final Grade: 4.2/5 (83.6%)						Assignment used for assessment: CH485 Writing Assignment 2		

Your Name: Dr. Biaglow				Cadets Assessed: All first-class chemical engineers (seniors)					
Your Position: CH485 Instructor				Major of Cadets Assessed: Chemical Engineering					
	1 – Needs Improvement	1	2	3 – Meets Expectations	3	4	5 – Exceeds Expectations	5	N/A
Contemporary	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.	4.8 ±.4	
Technical Competence	Demonstrates poor or incomplete understanding of transport phenomena.			Demonstrates some knowledge of the technical content, but explanation lacks depth.		4.6 ±.6	Demonstrates exceptional knowledge of technical content.		
Synthesis of Ideas	Does not connect contemporary issue with concepts in chemical engineering.			Makes connections with chemical engineering concepts, but the connections are weak or implied.		4.3 ±.8	Makes very clear connections between the issue and chemical engineering concepts.		
Communication	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.		4.3 ±.8	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? Yes	Comments: The rubrics were used to produce the grades given to the students. The essays were very well-written. Cadets were able to explain relevant transport phenomena, as well as demonstrate that the question and associated issues are contemporary. Raw data and analysis is found in the CH485 grades worksheet. Final Grade: 4.5/5 (90%)						Assignment used for assessment: CH485 Writing Assignment 3		

Your Name: MAJ Gerfen				Cadets Assessed: All second-class chemical engineers (juniors)					
Your Position: CH364 Instructor				Major of Cadets Assessed: Chemical Engineering					
	1 – Needs Improvement	1	2	3 – Meets Expectations	3	4	5 – Exceeds Expectations	5	N/A
Contemporary	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.	3.6 ±.6		Uses numerous examples and scholarly articles to illustrate contemporary nature of issue.	3.6 ±.8	
Technical Competence	Demonstrates poor or incomplete understanding of transport phenomena.			Demonstrates some knowledge of the technical content, but explanation lacks depth.	3.8 ±.8	4.2 ±.9	Demonstrates exceptional knowledge of technical content.		
Synthesis of Ideas	Does not connect contemporary issue with concepts in chemical engineering.			Makes connections with chemical engineering concepts, but the connections are weak or implied.	3.7 ±.7		Makes very clear connections between the issue and chemical engineering concepts.		
Communication	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.	3.6 ±.7		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? Yes	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: 3.7/5						Assignment used for assessment: CH364 Capstone Project		

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

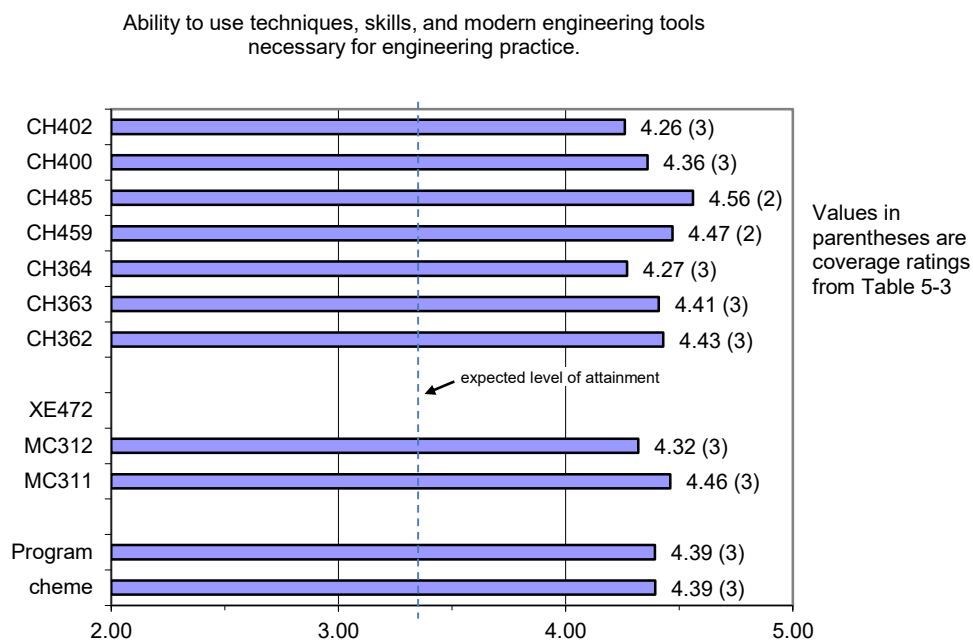


Figure 11-1. Coursework Embedded Indicator results for Student Outcome 11.

2. Fundamentals of Engineering Examination, Table 11-1.

Subject	USMA PI	ABET PI (expected level of attainment)	ABET PI S.D. (expected level of attainment)
Computational Tools	10.3	10.6	3.4

Performance Index (PI): As of this year, NCEES changed the manner in which it reports scores in subject areas. They now convert the score to a scale of 0-15, and they define this score as the performance index. NCEES also changed the comparator group that they report to USMA. They still report results for our institution, but for a comparison, they now report the results for students at other institutions who took the exam within 12 months prior to graduation, and they

define this as the ABET comparator. The ABET comparator performance index (PI) is now our expected level of attainment.

3. End of Semester Student Surveys

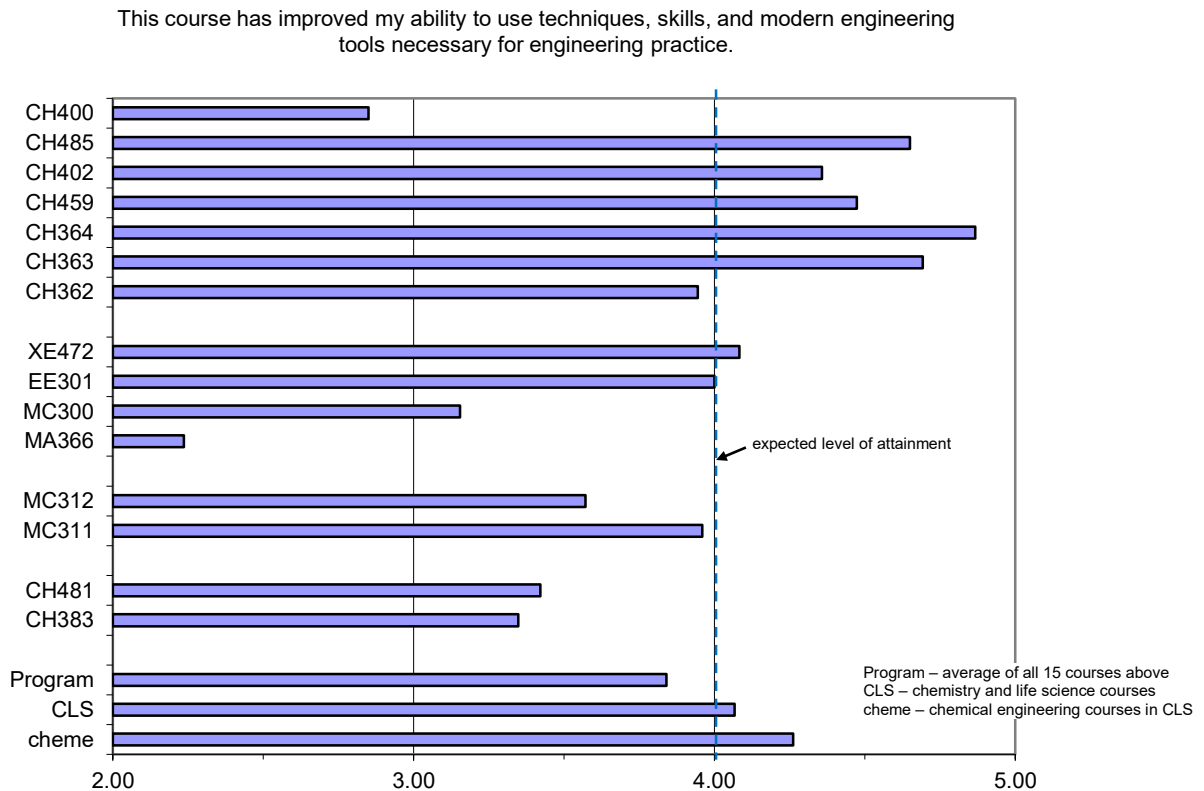


Figure 11-2. End-of-Semester Student Survey responses for Student Outcome 11.

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 21 cadets replied that they either agreed or strongly agreed, for a mean score of 4.49/5.00 for the 21 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.

Subject	USMA PI	ABET PI (expected level of attainment)	ABET PI S.D. (expected level of attainment)
Chemistry	11.2	10.7	3.1
Material and Energy Balances	8.8	9.5	2.3
Safety, Health, and Environment	8.9	9.4	3.4
Thermodynamics	9.5	9.5	2.0
Fluid Mechanics and Dynamics	8.8	9.9	2.3
Heat Transfer	9.2	10.0	2.5
Mass Transfer and Separations	9.3	9.4	2.0
Reaction Engineering	9.2	9.3	2.2
Process Control	8.6	9.4	3.0
Process Design and Economics	9.7	9.5	2.8
Computational Tools	10.3	10.6	3.4

Performance Index (PI): As of this year, NCEES changed the manner in which it reports scores in subject areas. They now convert the score to a scale of 0-15, and they define this score as the performance index. NCEES also changed the comparator group that they report to USMA. They still report results for our institution, but for a comparison, they now report the results for students at other institutions who took the exam within 12 months prior to graduation, and they define this as the ABET comparator. The ABET comparator performance index (PI) is now our expected level of attainment.

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	3.20								
CH481	Physical Chemistry I	3.45		3.45						
CH362	Mass & Energy Balances		3.63							
CH363	Separation Processes						3.55			
CH364	Chem. Reaction Eng.					3.28				
CH459	Chem. Eng. Laboratory									3.67
CH485	Heat and Mass Transfer				3.58					
CH400	Chemical Engineering Sem.			3.87		3.87	3.87	3.87		
CH402	Chem. Eng. Process Des.								3.40	
MA366	Vector Calculus									
ME311	Thermal-Fluid Systems I			3.64	3.64					
ME312	Thermal-Fluid Systems II			2.97	2.97					
CE300	Fund. Eng. Mech. & Des.									
EE301	Intro. To Elec. Engineering									
XE472	Dyn. Modeling & Control							3.33		
<i>Average Grade 2015</i>		<i>3.33</i>	<i>3.63</i>	<i>3.43</i>	<i>3.33</i>	<i>3.72</i>	<i>3.71</i>	<i>3.60</i>	<i>3.40</i>	<i>3.67</i>
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
<i>Previous 5-year Running Average (expected level of attainment)</i>		<i>3.29</i>	<i>3.51</i>	<i>3.47</i>	<i>3.52</i>	<i>3.45</i>	<i>3.45</i>	<i>3.44</i>	<i>3.39</i>	<i>3.56</i>
Standard Deviation 2015		0.74	0.67	0.71	0.72	0.59	0.59	0.76	0.95	0.37

Note: These scores are grade point averages (GPAs) for courses, where the value is calculated from the letter grade issued to the cadets in their transcripts.

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

Chemical Engineering Student Outcomes	Faculty Evaluation
On completion of the chemical engineering program, our graduates will be able to:	
1. Apply knowledge of mathematics, science, and engineering.	4.80±0.45
2. Design and conduct experiments, as well as analyze and interpret data.	4.40±0.89
3. Design a system, component, or process to meet desired needs within economic, environmental, social, political, ethical, health and safety, manufacturing, and sustainability constraints.	4.40±0.89
4. Function on multidisciplinary teams.	4.80±0.45
5. Identify, formulate, and solve engineering problems.	4.80±0.45
6. Understand professional and ethical responsibilities.	4.80±0.45
7. Communicate effectively.	4.60±0.89
8. Understand the impact of engineering solutions in a global economic, environmental, and societal context.	4.40±0.55
9. Recognize the need and develop the skills required for life-long learning.	4.40±0.89
10. Demonstrate knowledge of contemporary issues.	4.80±0.45
11. Demonstrate an ability to use techniques, skills, and modern engineering tools necessary for engineering practice.	4.60±0.89
12. 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.	4.40±0.55
5- Excellent; 4 – Very Good; 3 – Acceptable; 2 – Weak ; 1 – Poor	

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

Chemical Engineering Student Outcomes	Advisory Board's Evaluation
On completion of the chemical engineering program, our graduates will be able to:	
1. Apply knowledge of mathematics, science, and engineering.	4.73±0.47
2. Design and conduct experiments, as well as analyze and interpret data.	4.22±0.44
3. Design a system, component, or process to meet desired needs within economic, environmental, social, political, ethical, health and safety, manufacturing, and sustainability constraints.	4.60±0.52
4. Function on multidisciplinary teams.	4.82±0.40
5. Identify, formulate, and solve engineering problems.	4.45±0.52
6. Understand professional and ethical responsibilities.	4.91±0.30
7. Communicate effectively.	4.91±0.30
8. Understand the impact of engineering solutions in a global economic, environmental, and societal context.	4.73±0.47
9. Recognize the need and develop the skills required for life-long learning.	4.91±0.30
10. Demonstrate knowledge of contemporary issues.	4.36±0.67
11. Demonstrate an ability to use techniques, skills, and modern engineering tools necessary for engineering practice.	4.55±0.69
12. 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.	4.64±0.50
5- Excellent; 4 – Very Good; 3 – Acceptable; 2 – Weak ; 1 – Poor	

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.	4
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. 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	