

PROGRAM ASSESSMENT DATA AY2016-2017

UNITED STATES MILITARY ACADEMY
DEPARTMENT OF CHEMISTRY AND LIFE SCIENCE
CHEMICAL ENGINEERING PROGRAM
August 18, 2017

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Note: This data was intended to allow completion of the faculty and advisory board surveys. The different groups review the data first and then complete the survey. The results of the surveys are then summarized in the “Evaluations” section.

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

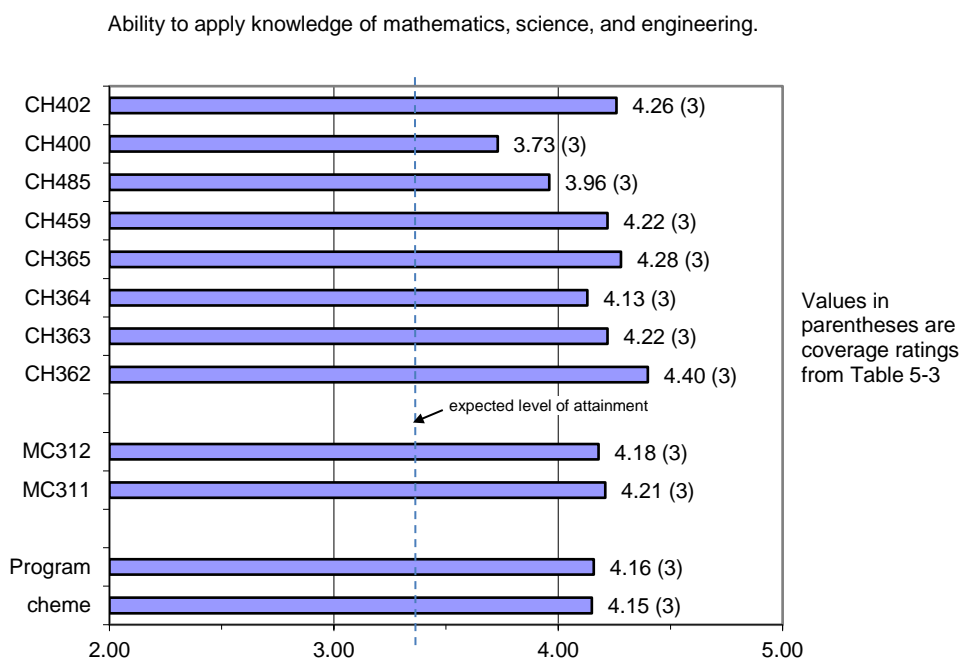


Figure 1-1. Coursework Embedded Indicator results for Student Outcome 1.

2. Fundamentals of Engineering Examination (FEE). According to the 2017 report from NCEES, 14 out of 16, or 88% of the students in the Class of 2017 took and passed the FE Exam. The national average in 2017 was 74%, and this is our expected level of attainment. In the previous five years, the pass rates were 79% in 2016, 76% in 2015, 92% in 2014, 93% in 2013, and 92% in 2012. The running average for our cadets over those years is $87\% \pm 8\%$ ($81\% \pm 5\%$ for the national).

Notes: (1) In 2017, two cadets failed the exam on the first try re-took the exam, and one of them passed the second attempt. **Therefore, the true pass rate is 15/16, or 94%.** (2) The national percentage of chemical engineering examinees passing was 86% for many years prior to 2015. However, as of that year, NCEES changed our comparator group from all takers to those first-time takers taking the exam within 12 months of graduation. Also, a new chemical engineering exam was implemented that year. As a result of these changes, the national average dropped to 77% (79% this year). That is, we are exactly at the national average and the national average is our expected level of attainment.

3. End of Semester Student Surveys

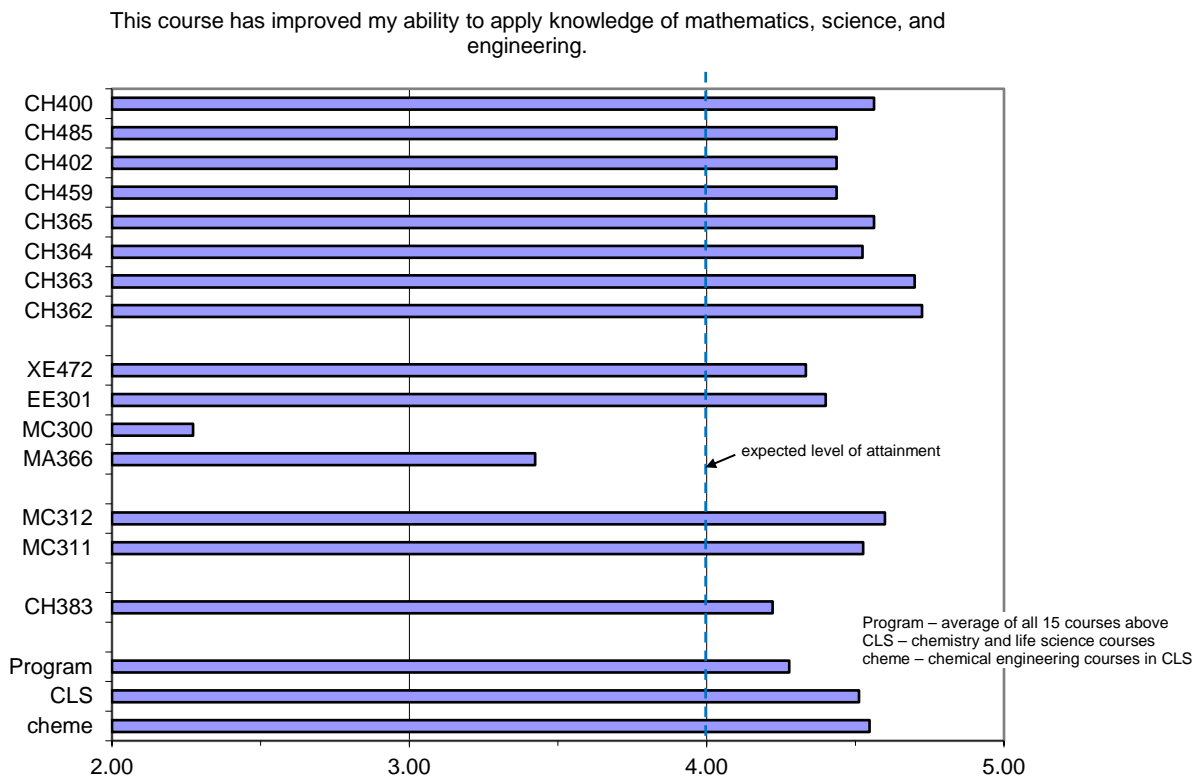


Figure 1-2. End-of-Semester Student Survey responses for Student Outcome 1.

4. Chemical Engineering Program Exit Survey. This survey is 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.” 16 out of 16 cadets completed the survey. All 16 cadets of the cadets who replied said that they either agreed or strongly agreed, and 12/16 replied that they strongly agreed (score = 5/5). This equates to a mean score of 4.760/5.00 for the 16 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

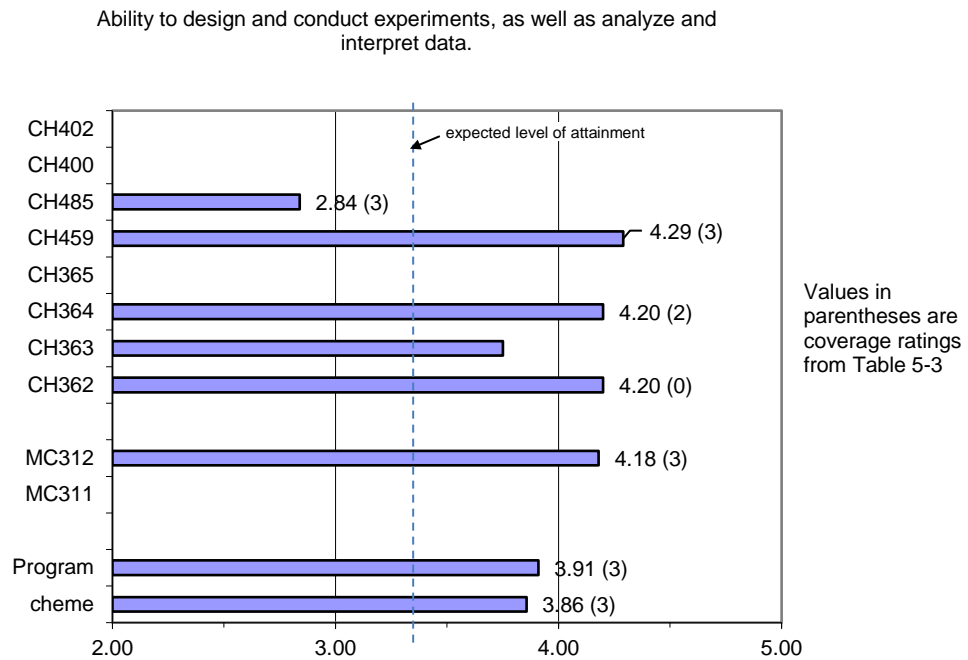


Figure 2-1. Coursework Embedded Indicator results for Student Outcome 2.

2. End of Semester Student Surveys

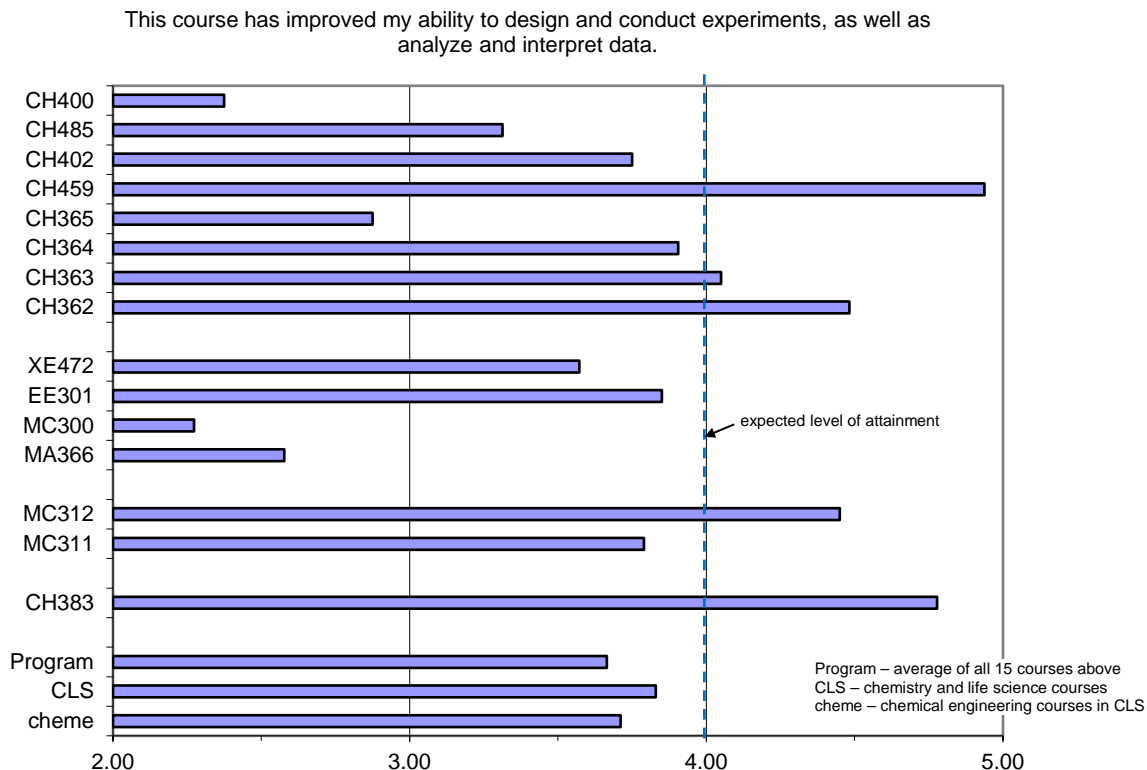


Figure 2-2. End-of-Semester Student Survey responses for Student Outcome 2.

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.” 16 out of 16 cadets completed the survey. All 16 cadets of the cadets who replied said that they either agreed or strongly agreed, and 9/16 replied that they strongly agreed (score = 5/5). This equates to a mean score of 4.563/5.00 for the 16 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 3.54 ± 0.30 (n=16) in AY17, compared to 3.70 ± 0.35 (n=23) in AY16, 3.67 ± 0.37 (n=20) in AY15, 3.87 ± 0.44 (n=13) in AY14, 3.59 ± 0.47 (n=14) for AY13, and 3.64 ± 0.40 (n=13) for AY12. There were no failures over the last six years. *The 5-year running average is 3.69, and this is our expected level of attainment. This year's score was 0.15 GPA units below the five year running average, which is low, but the difference is statistically insignificant.*

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

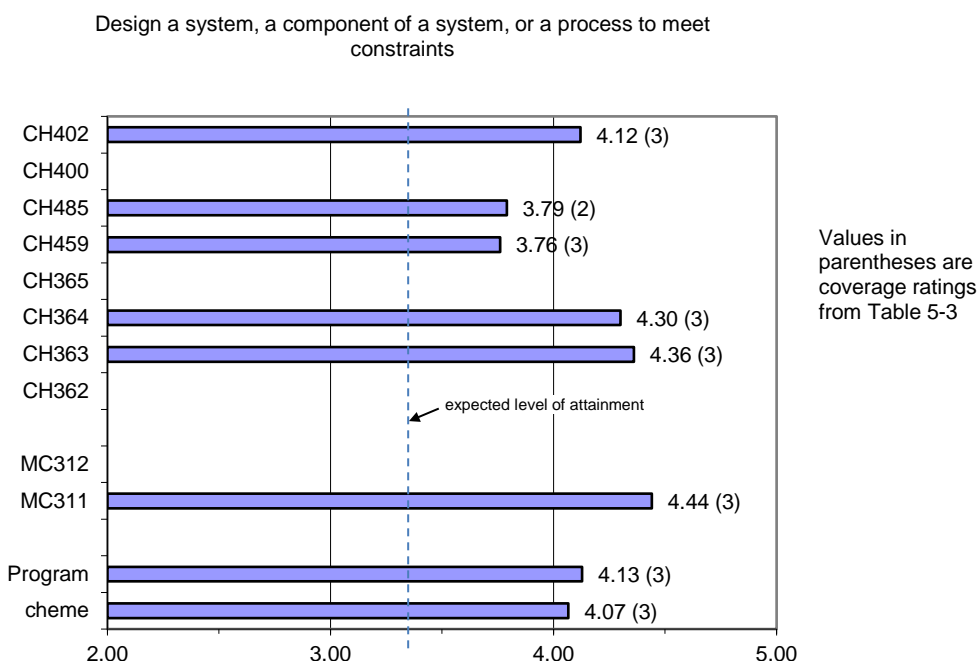


Figure 3-1. Coursework Embedded Indicator results for Student Outcome 3.

2. End of Semester Student Surveys

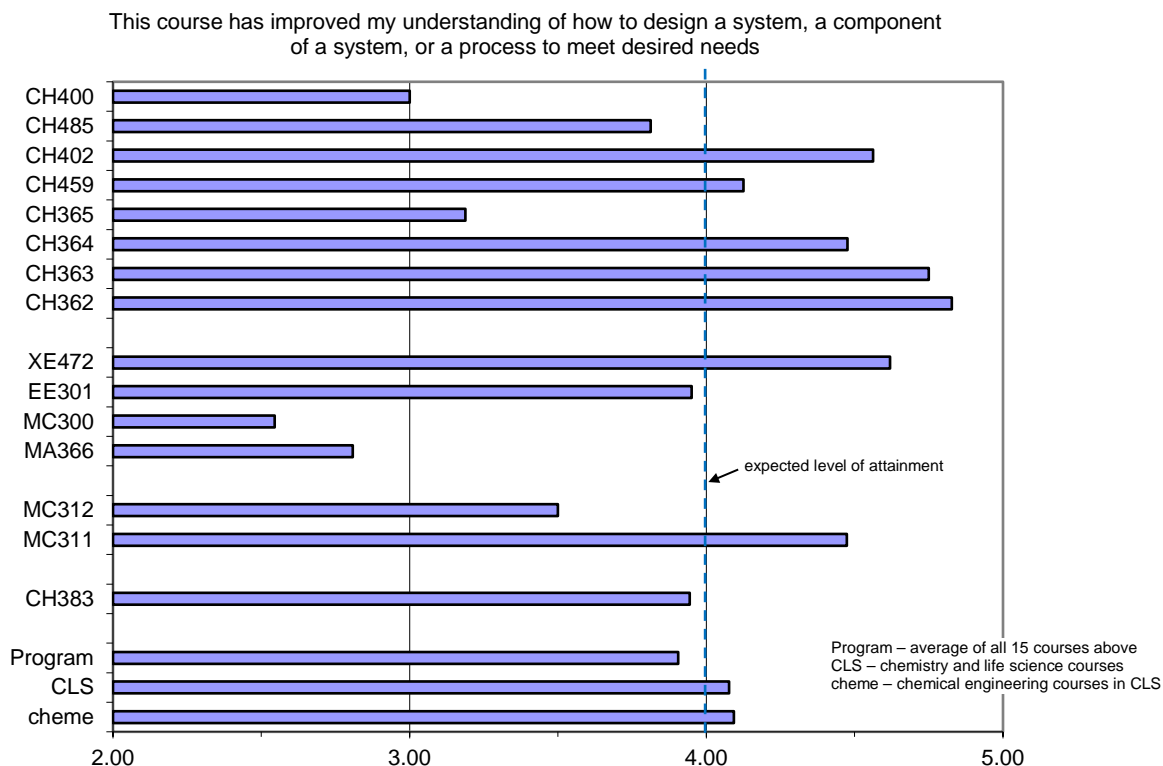


Figure 3-2. End-of-Semester Student Survey responses for Student Outcome 3.

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.” 16 out of 16 cadets completed the survey. Of those who completed the survey, 9/16 cadets replied that they strongly agreed (score = 5/5), 5/16 replied that they agreed (score = 4/5), and 2/16 were neutral (score = 3/5). This equates to a mean score of 4.438/5.00 for the 23 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 2.73 ± 0.39 ($n=16$) in AY17, compared to 3.43 ± 0.49 ($n=24$) in AY16, 3.40 ± 0.75 ($n=20$) in AY15, 3.23 ± 0.71 ($n=13$) for AY14, 3.64 ± 0.55 ($n=14$) for AY13, and 3.69 ± 0.50 for AY12. There were no failures over the last six years. *The 5-year running average for the previous five years is 3.48, and this is our expected level of attainment. This year’s score was 0.75 below the five year running average. This number is significantly below the 5-year running average.*

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

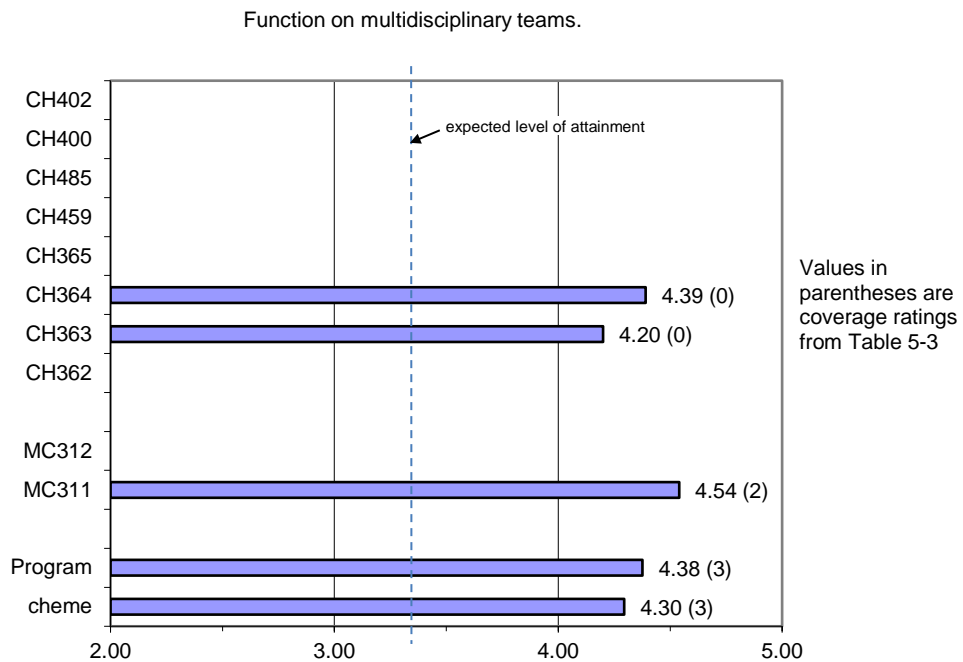


Figure 4-1. Coursework Embedded Indicator results for Student Outcome 4.

2. End of Semester Student Surveys

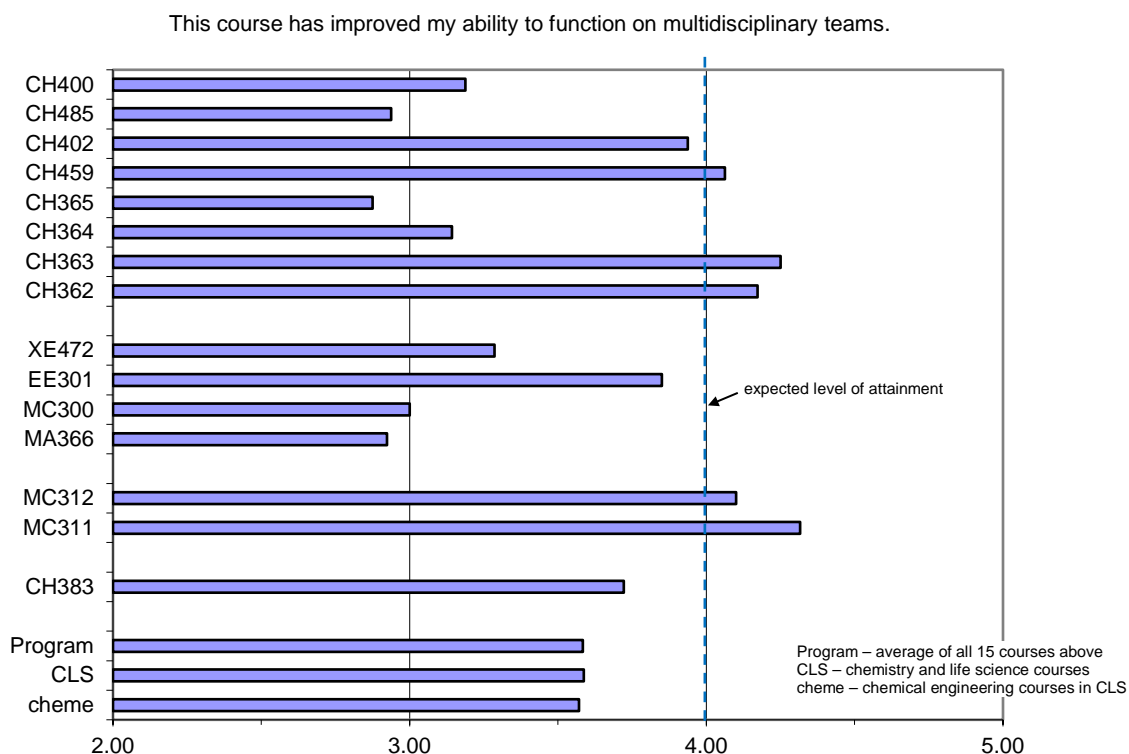


Figure 4-2. End-of-Semester Student Survey responses for Student Outcome 4.

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.” 16 out of 16 cadets completed the survey. Of those who completed the survey, 9/16 cadets replied that they strongly agreed (score = 5/5), 6/16 replied that they agreed (score = 4/5), and 1/16 was neutral (score = 3/5). This equates to a mean score of 4.500/5.00 for the 16 cadets. The expected level of attainment on this survey is 4.00/5.00.
4. Multidisciplinary Skills Rubric. The rubric appears on the following page, with averages of responses from cadets. The rubric 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 their team leader. 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 Leader Assessment or GLA). The team leader also uses the rubric for self-assessment (Leader Self Assessment or LSA), indicated with a superscript “b.” The colors in the rubric indicate the expected level of attainment, where green

indicates that expectations are exceeded, yellow indicates that expectations are minimally 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: Armstrong, LTC, Instructor				Person Assessed: 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.			Exceptional knowledge of technical content.	4.9 ^a 4.8 ^b	
Communication	Lacked sensitivity and/or did not provide specific suggestions for improvement.			Effectively communicated important points.			Exceptional ability to explain important points. Very effectively communicated ideas for improvement.	4.8 ^a 4.5 ^b	
Organization	Was not prepared or did not give sufficient time to prepare.			Demonstrated effective organization during class.			Was exceptionally efficient, timely and responsive throughout the entire process.	4.8 ^a 4.8 ^b	
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.	4.9 ^a 4.9 ^b	
Are the cadets capable of functioning on multidisciplinary teams? Yes	Comments: Since there were 6 projects and 6 groups, each cadet was 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 0.2 to 0.4, with an average standard deviation of 0.29.								

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

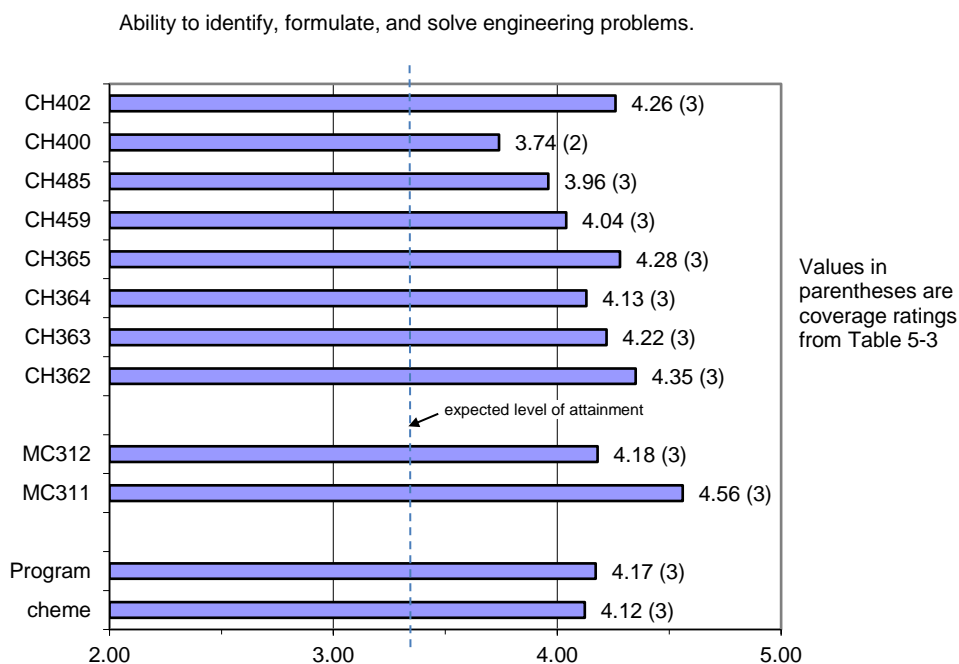


Figure 5-1. Coursework Embedded Indicator results for Student Outcome 5.

2. Fundamentals of Engineering Examination (FEE). According to the 2017 report from NCEES, 14 out of 16, or 88% of the students in the Class of 2017 took and passed the FE Exam. The national average in 2017 was 74%, and this is our expected level of attainment. In the previous five years, the pass rates were 79% in 2016, 76% in 2015, 92% in 2014, 93% in 2013, and 92% in 2012. The running average for our cadets over those years is $87\% \pm 8\%$ ($81\% \pm 5\%$ for the national).

Notes: (1) In 2017, two cadets failed the exam on the first try re-took the exam, and one of them passed the second attempt. **Therefore, the true pass rate is 15/16, or 94%.** (2) The national percentage of chemical engineering examinees passing was 86% for many years prior to 2015. However, as of that year, NCEES changed our comparator group from all takers to those first-time takers taking the exam within 12 months of graduation. Also, a new chemical engineering exam was implemented that year. As a result of these changes, the national average dropped to 77% (79% this year). That is, we are exactly at the national average and the national average is our expected level of attainment.

3. End of Semester Student Surveys

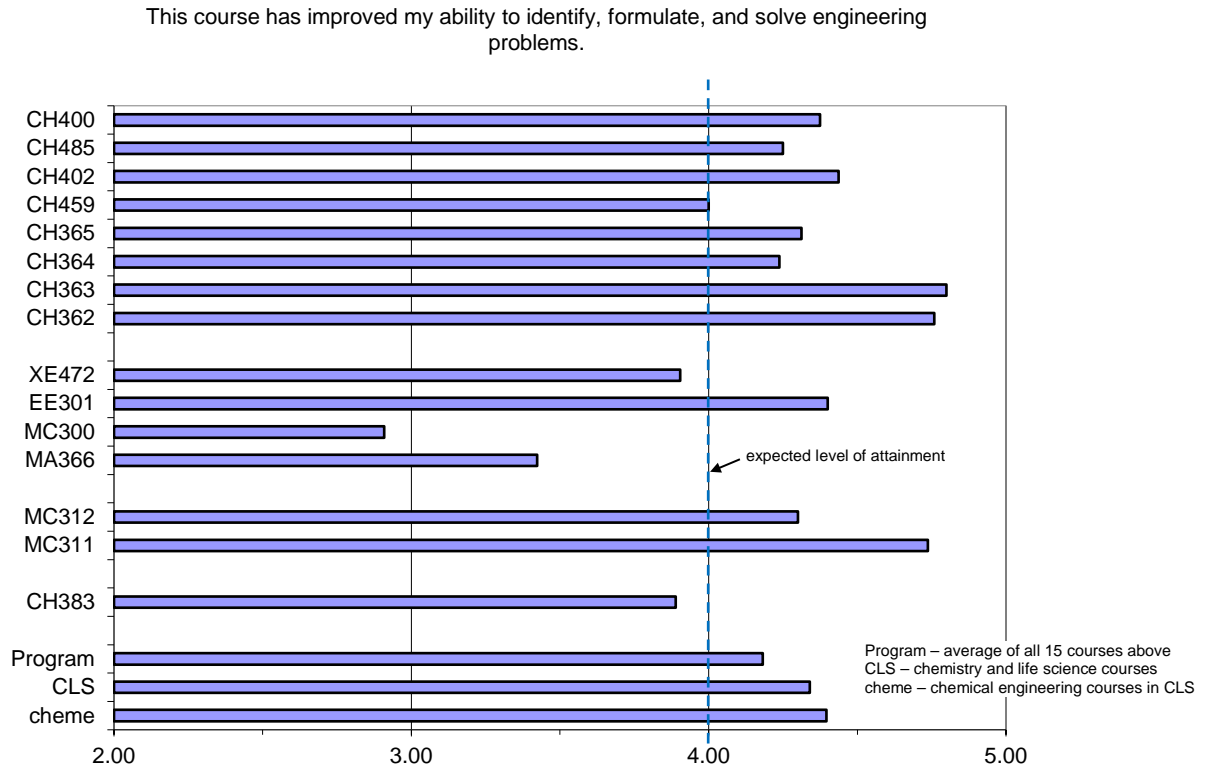


Figure 5-2. End-of-Semester Student Survey responses for Student Outcome 5.

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.” 16 out of 16 cadets completed the survey. All 16 cadets of the cadets who replied said that they either agreed or strongly agreed, and 11/16 replied that they strongly agreed (score = 5/5). This equates to a mean score of 4.688/5.00 for the 16 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 Performance Index, 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

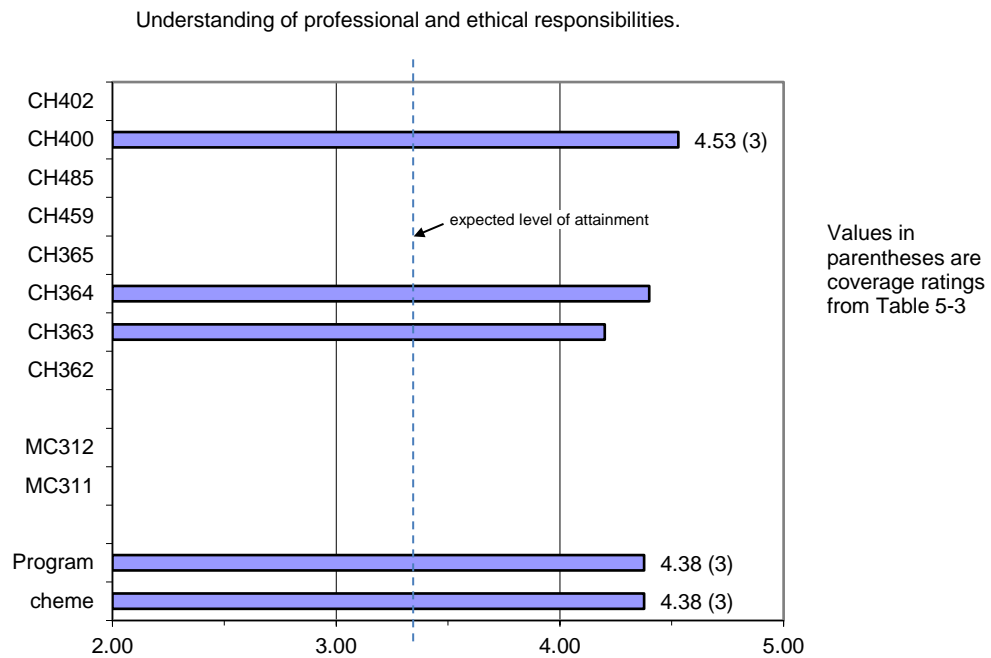


Figure 6-1. Coursework Embedded Indicator results for Student Outcome 6.

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

Subject	Outcome	Questions	USMA	National (expected level of attainment)
Ethics and Professional Practices	6	2	11.1	11.3

The national average performance index was 11.3 in this subject, and this is our expected level of attainment. The standard deviation on the national index is 5.1.

3. End of Semester Student Surveys

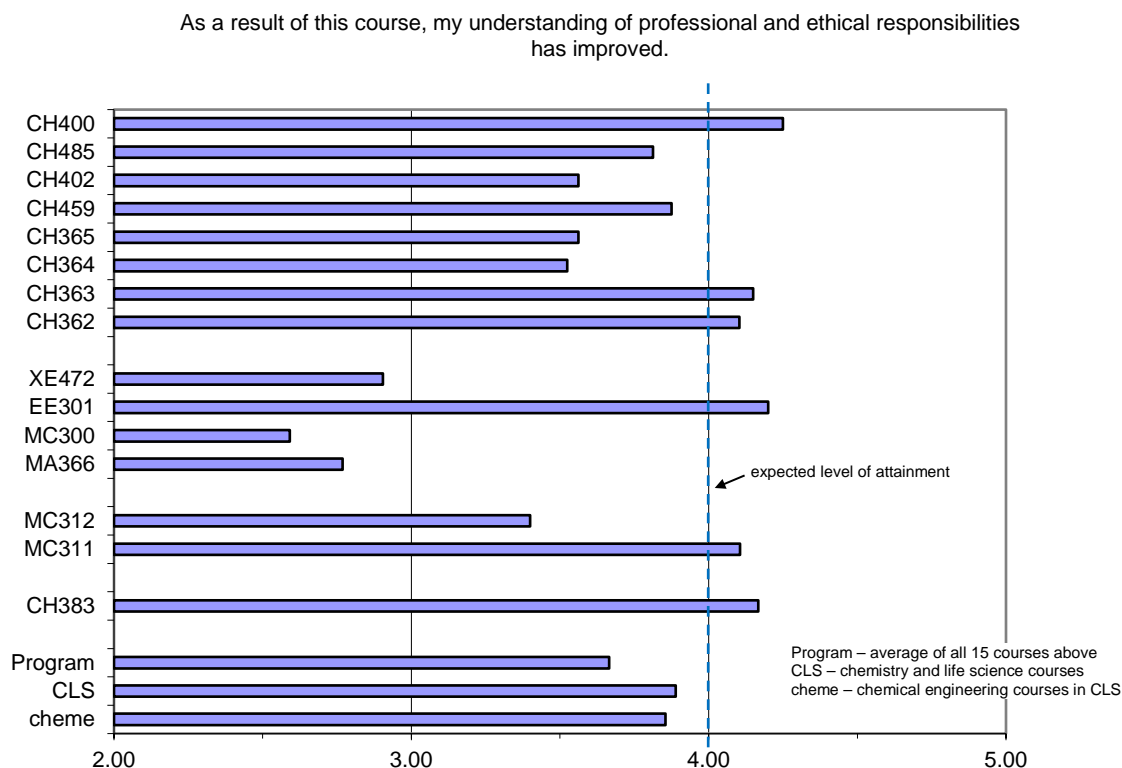


Figure 6-2. End-of-Semester Student Survey responses for Student Outcome 6.

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.” 16 out of 16 cadets completed the survey. Of those, 9/16 cadets replied that they strongly agreed (score = 5/5), 5/16 replied that they agreed (score = 4/5), 1/16 was neutral (score = 3/5), and 1/6 disagreed. This equates to a mean score of 4.375/5.00 for the 16 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 16 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

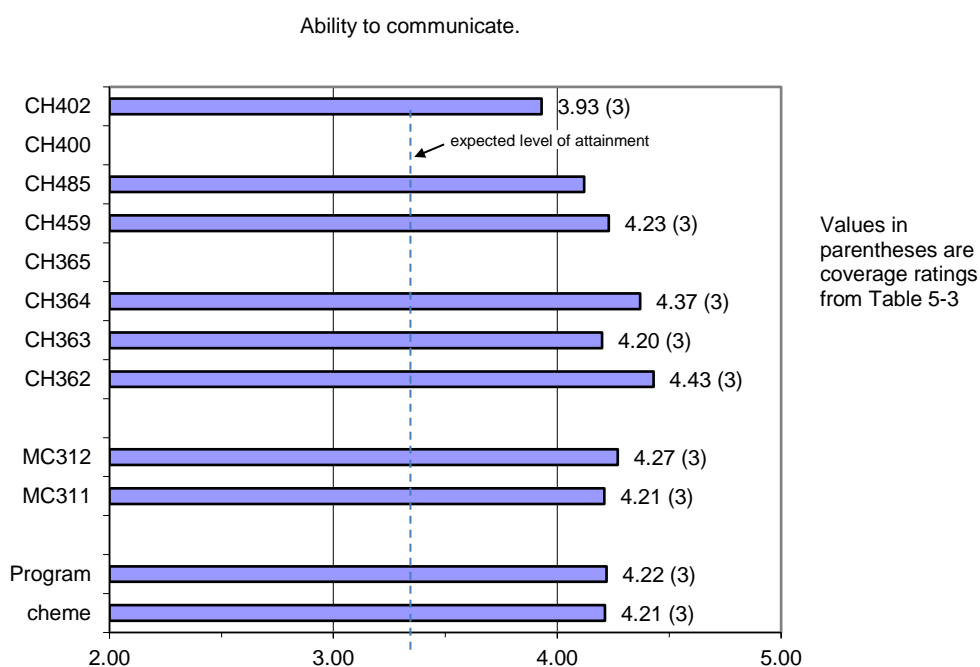


Figure 7-1. Coursework Embedded Indicator results for Student Outcome 7.

2. End of Semester Student Surveys

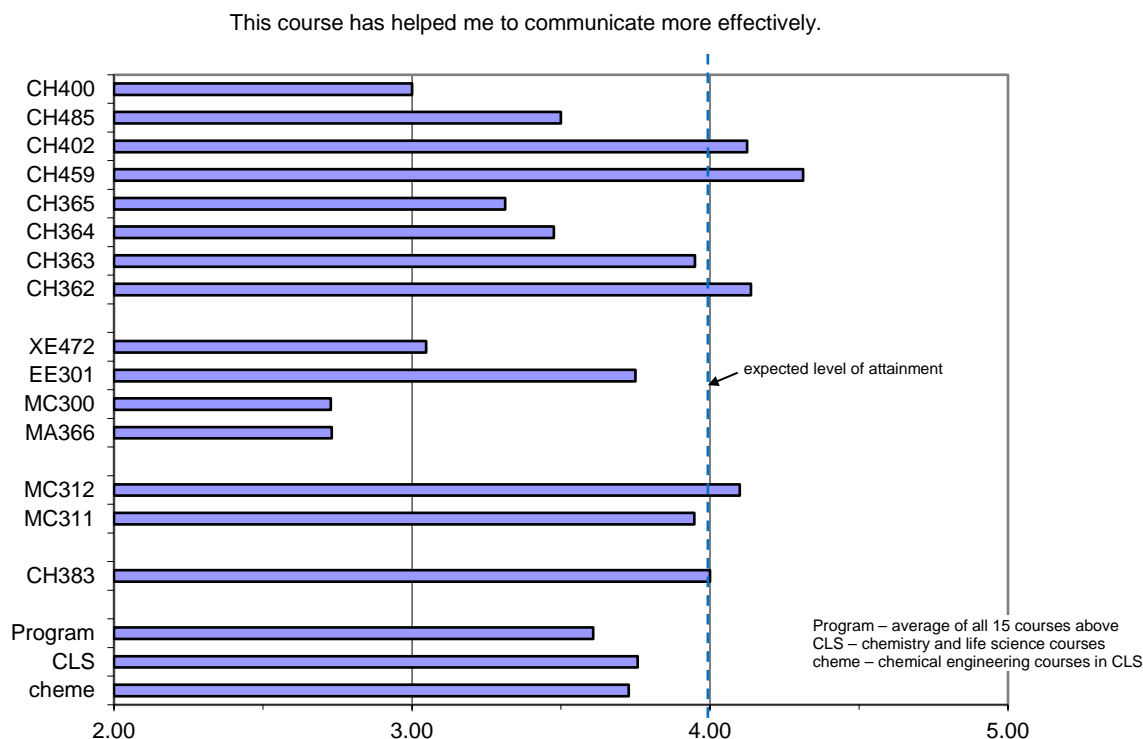


Figure 7-2. End-of-Semester Student Survey responses for Student Outcome 7.

- The average course grade in CH459 Chemical Engineering Laboratory was 3.54 ± 0.30 ($n=16$) in AY17, compared to 3.70 ± 0.35 ($n=23$) in AY16, 3.67 ± 0.37 ($n=20$) in AY15, 3.87 ± 0.44 ($n=13$) in AY14, 3.59 ± 0.47 ($n=14$) for AY13, and 3.64 ± 0.40 ($n=13$) for AY12. There were no failures over the last six years. *The 5-year running average is 3.69, and this is our expected level of attainment. This year's score was 0.15 GPA units above the five year running average, which is low, but the difference is statistically insignificant.*
- 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." 16 out of 16 cadets completed the survey. Of those who completed the survey, 8/16 cadets replied that they strongly agreed (score = 5/5), 6/16 replied that they agreed (score = 4/5), and 2/16 were neutral (score = 3/5). This equates to a mean score of 4.375/5.00 for the 16 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 Performance Index, 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

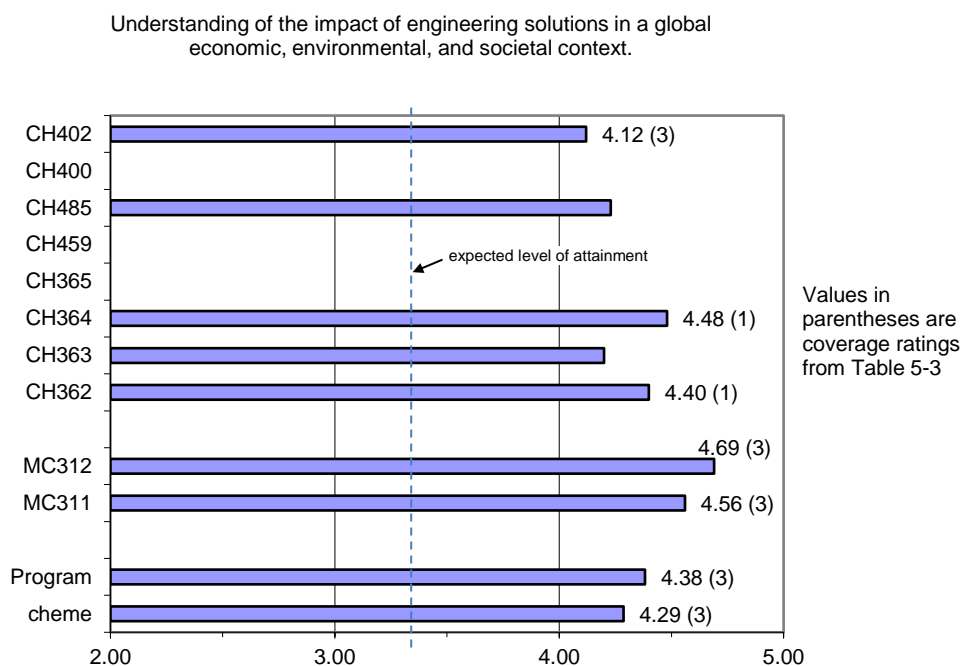


Figure 8-1. Coursework Embedded Indicator results for Student Outcome 8.

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

Subject	Outcome	Questions	USMA	National % (expected level of attainment)
Process Design and Economics	8	8	9.8	9.8

The national average performance index was 9.8 in this subject, and this is our expected level of attainment. The standard deviation on the national index is 2.8.

3. End of Semester Student Surveys

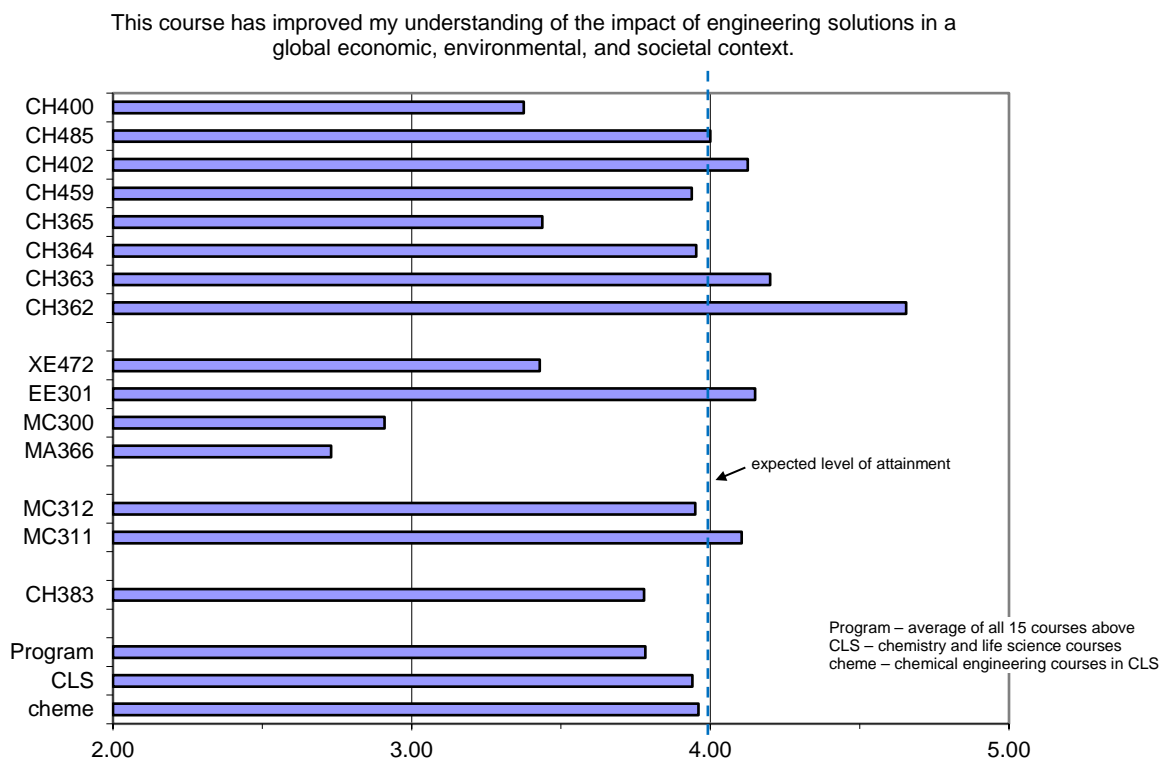


Figure 8-2. End-of-Semester Student Survey responses for Student Outcome 8.

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.” 16 out of 16 cadets completed the survey. Of those, 6/16 cadets replied that they strongly agreed (score = 5/5), 9/16 replied that they agreed (score = 4/5), and 1/6 disagreed. This equates to a mean score of 4.250/5.00 for the 16 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, twice per year.

Assessment Results:

1. Chemical & Mechanical Engineering Coursework Embedded Indicators

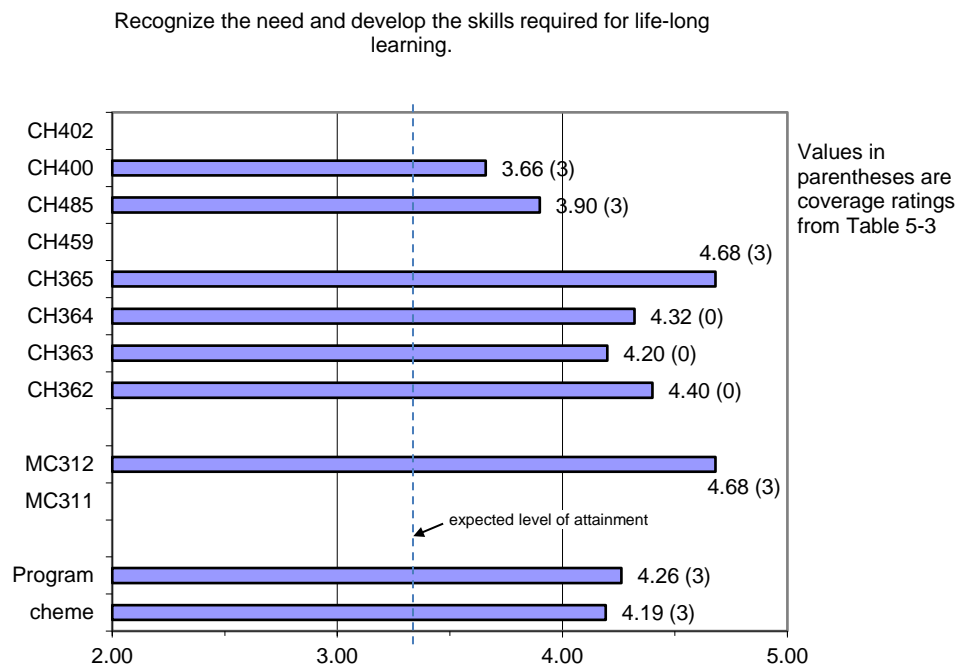


Figure 9-1. Coursework Embedded Indicator results for Student Outcome 9.

2. Percent of Eligible Cadets taking the Fundamentals of Engineering Examination (FEE). For the Class of 2017, 16 chemical engineering cadets (100% of the eligible cadets) prepared for and took the FEE. This compares to 100% in 2016, 100% in 2015, 100% in 2014, 100% in 2013, and 100% in 2012. Since all of our cadets prepare for the exam in CH400, our expected level of attainment is 100%. Additionally, on average, approximately 25% of the graduating chemical engineers nationwide and 93% of the graduating engineers from all disciplines at the USMA take the FEE.

3. End of Semester Student Surveys

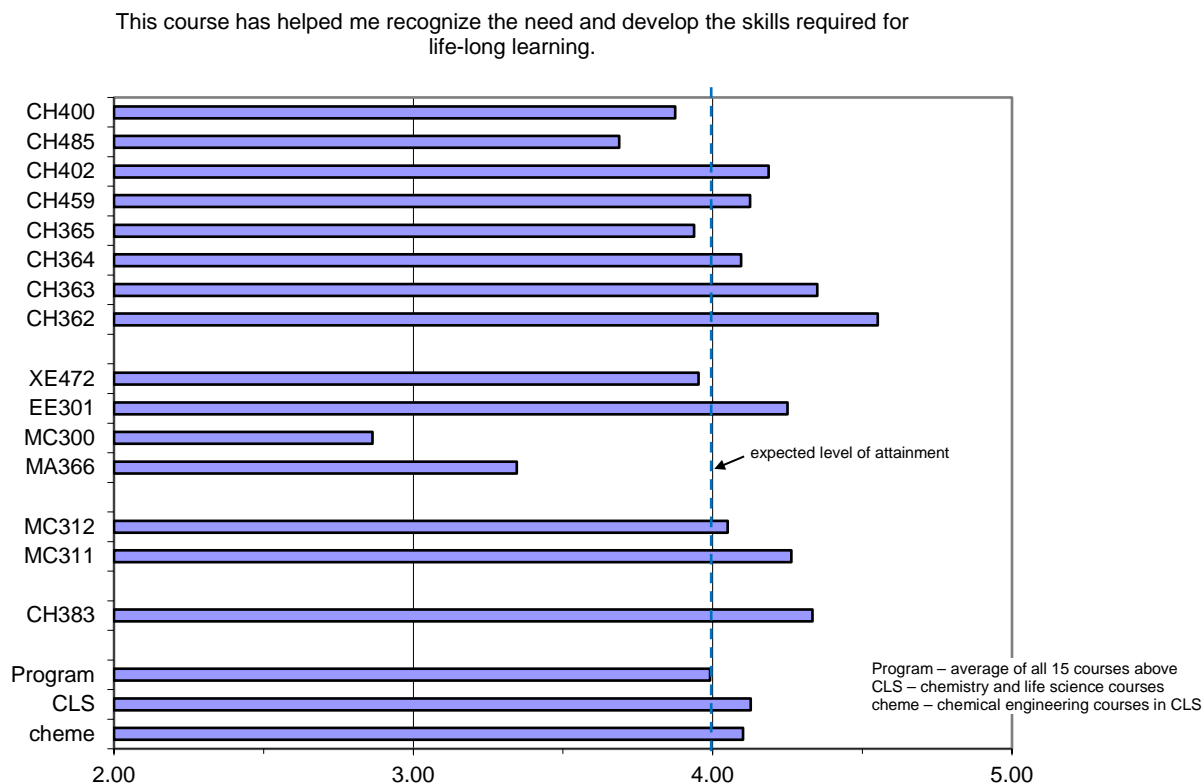


Figure 9-2. End-of-Semester Student Survey responses for Student Outcome 9.

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.” 16 out of 16 cadets completed the survey. Of those who completed the survey, 9/16 cadets replied that they strongly agreed (score = 5/5), 6/16 replied that they agreed (score = 4/5), and 1/16 was neutral (score = 3/5). This equates to a mean score of 4.500/5.00 for the 16 cadets. The expected level of attainment is 4.00/5.00.
5. Lifelong Learning Skills Rubric. The lifelong learning skills rubric is designed to assess performance in four skills associated with recognizing the need and develop the skills required for life-long learning: (1) engagement of the cadet in pre-professional activities, (2) recognition of the development of professional skills, (3) demonstration of intellectual growth, and (4) the ability to communicate these features to other professionals. The rubrics shown here were completed by the instructor to assess the cadets using writing assignments 1 and 2 in CH365 (writin a resume at the beginning of the semester, then revising it at the end. The results are shown below using the actual rubric for format. The average score for each rubric element is shown for all all of the cadets in the course. The expected levels of attainment are color-coded, with red indicating a need for improvement, yellow

indicating minimal performance, and green indicating that expectations are met or exceeded. Instructor comments are also shown in the rubrics.

Your Name: Biaglow				Cadet Assessed: All first-class chemical engineers (seniors)					
Your Position: Professor, CH365				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.		4.6 ±0.6	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.		4.7 ±0.5	Identifies specific skills learned in chemical engineering courses.		
Intellectual Growth	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.		4.6 ±0.6	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.		4.7 ±0.4	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: In general, cadets did a very nice job on this assignment and scores were increased significantly over last year. However, the assignment was later in the semester and cadets received a lot of critique prior to final submission. Final Grade: 4.7/5 = 94%						Assignment used for assessment: CH485 Writing Assignment 1 - Resumes		

Your Name: Biaglow				Cadet Assessed: All first-class chemical engineers (seniors)					
Your Position: Professor, CH400				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.	5.0 ±0.0	
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 ±0.4	
Intellectual Growth	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.	4.8 ±0.4	
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.			Demonstrates an ability to effectively communicate in the resume format. Clear, concise content. Resume is interesting.	4.9 ±0.3	
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, helped a lot. In general, all resumes improved over the first draft from the fall. Final Grade: 4.9/5 = 97%						Assignment used for assessment: CH400 Writing Assignment 2 – Resume Revision		

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

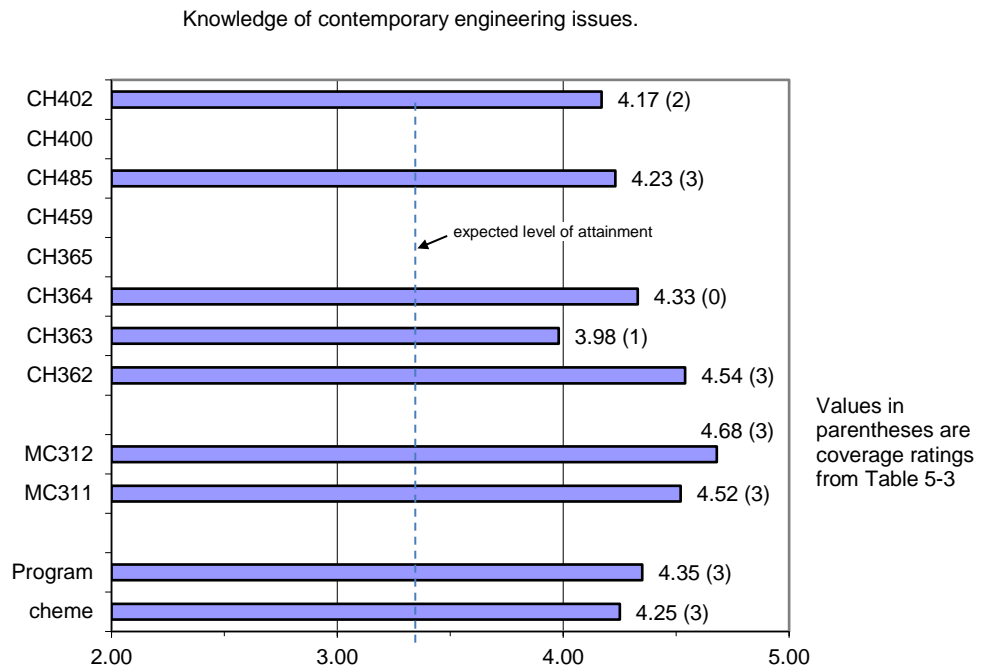


Figure 10-1. Coursework Embedded Indicator results for Student Outcome 10.

2. End of Semester Student Surveys

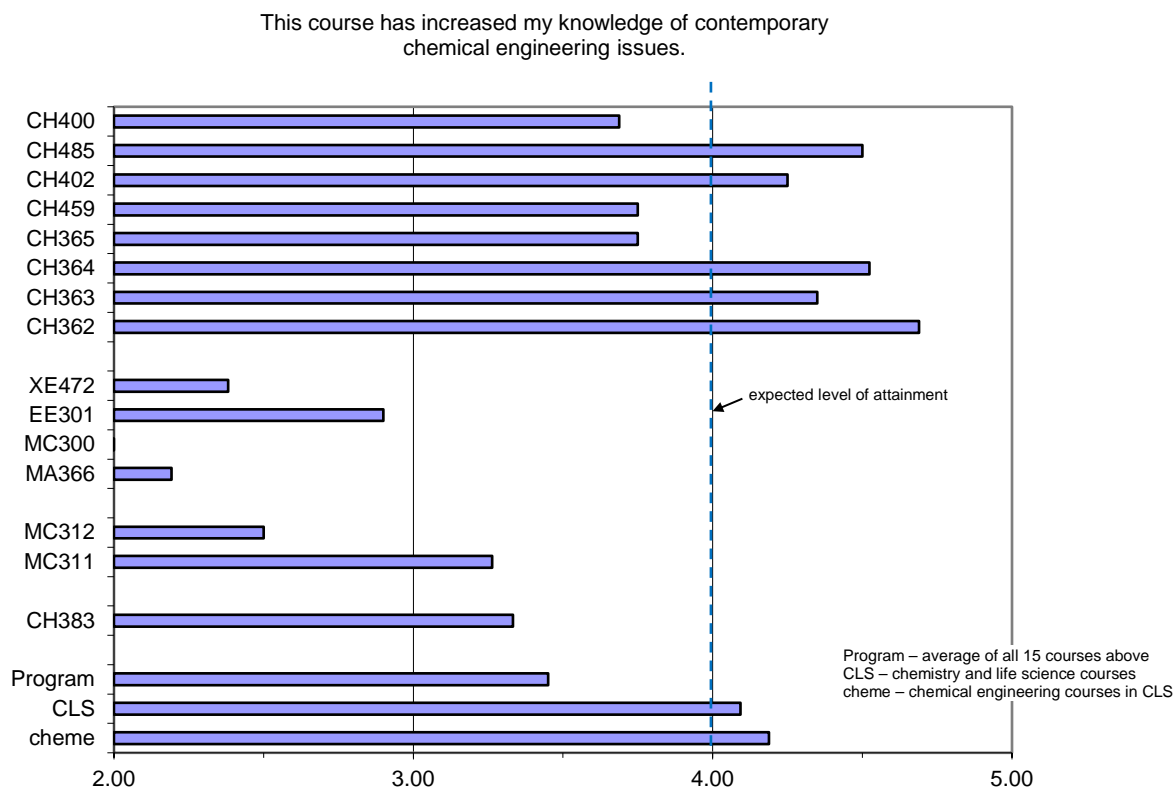


Figure 10-2. End-of-Semester Student Survey responses for Student Outcome 10.

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.” 16 out of 16 cadets completed the survey. Of those, 4/16 cadets replied that they strongly agreed (score = 5/5), 9/16 replied that they agreed (score = 4/5), 1/16 was neutral (score = 3/5), and 1/6 strongly disagreed (score = 1/5). This equates to a mean score of 3.938/5.00 for the 16 cadets. The expected level of attainment on this survey is 4.00/5.00.
4. Contemporary Issues Rubric. The contemporary issues rubric 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 instructor for specific assignments in his or her course. In this case, LTC Bull used two writing assignments in CH485. The results are summarized on the following page, using the actual rubric to format the results, with cadet average scores shown for each rubric item. The expected levels of attainment are color-coded red (indicating a need for improvement), yellow (minimal level of performance), and green (expectations are exceeded).

Your Name: LTC Bull				Cadets Assessed: All first-class chemical engineers (firsties)					
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.		4.4 ±.5	Uses numerous examples and scholarly articles to illustrate contemporary nature of issue.		
Technical Competence	Demonstrates poor or incomplete understanding of transport phenomena.		2.9 ±.6	Demonstrates some knowledge of the technical content, but explanation lacks depth.			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.	3.8 ±.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.		4.1 ±.6	Demonstrates an ability to effectively communicate in the essay format. Fully supported, clear, concise thesis. Writing style was exceptionally clear and articulate.		
<div>Have the cadets demonstrated knowledge of contemporary issues? Yes</div> <div>Comments: The rubrics were used to produce the grades given to the students. Most of the cadets demonstrated significant improvement in their writing from assignment 1F. The technical competence was very lacking on this assignment and for many gave the distinct impression that they tried writing it within a day or two of its due date, affecting their ability to synthesize their ideas as well. Few requested instructor feedback prior to turning in the assignment and this, also, was reflected in their final scores. Without the instructor feedback, I think this was a better assessment of cadets' writing abilities than the previous one and is only in the 'Meets Expectations' as an average. There was certainly some work that did not. Final Grade: 3.8/5</div> <div>Assignment used for assessment: CH485 Writing Assignment 2</div>									
Your Name: LTC Bull				Cadets Assessed: All first-class chemical engineers (firsties)					
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.	5.0 ±.0	
Technical Competence	Demonstrates poor or incomplete understanding of transport phenomena.			Demonstrates some knowledge of the technical content, but explanation lacks depth.		4.3 ±.5	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.		4.2 ±0.6	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.	3.8 ±.5		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 topic was provided to the cadets, thus the score for contemporary. Since this assignment was near the midpoint of the course, some technical knowledge was lacking. However, most of the points were lost in the synthesis and communications portions. The cadets did not demonstrate strong writing skills, especially so because this was a revision of a previous assignment on which I provided detailed feedback. Final Grade: 4.3/5						Assignment used for assessment: CH485 Writing Assignment 1F		
Your Name: LTC Bull			Cadets Assessed: All first-class chemical engineers (firsties)						
Your Position: CH485 Instructor			Major of Cadets Assessed: Chemical Engineering						

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 Performance Index, 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

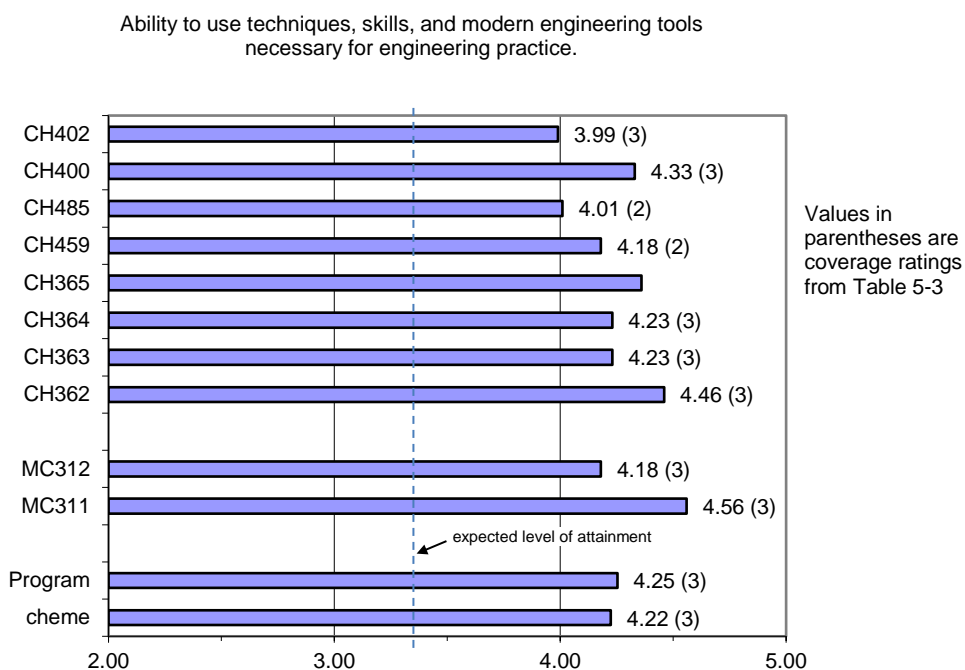


Figure 11-1. Coursework Embedded Indicator results for Student Outcome 11.

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

Subject	Outcome	Questions	USMA	National % (expected level of attainment)
Computational Tools	11	4	9.3	9.9

The national average performance index was 9.9 in this subject, and this is our expected level of attainment. The standard deviation on the national index is 3.4.

3. End of Semester Student Surveys

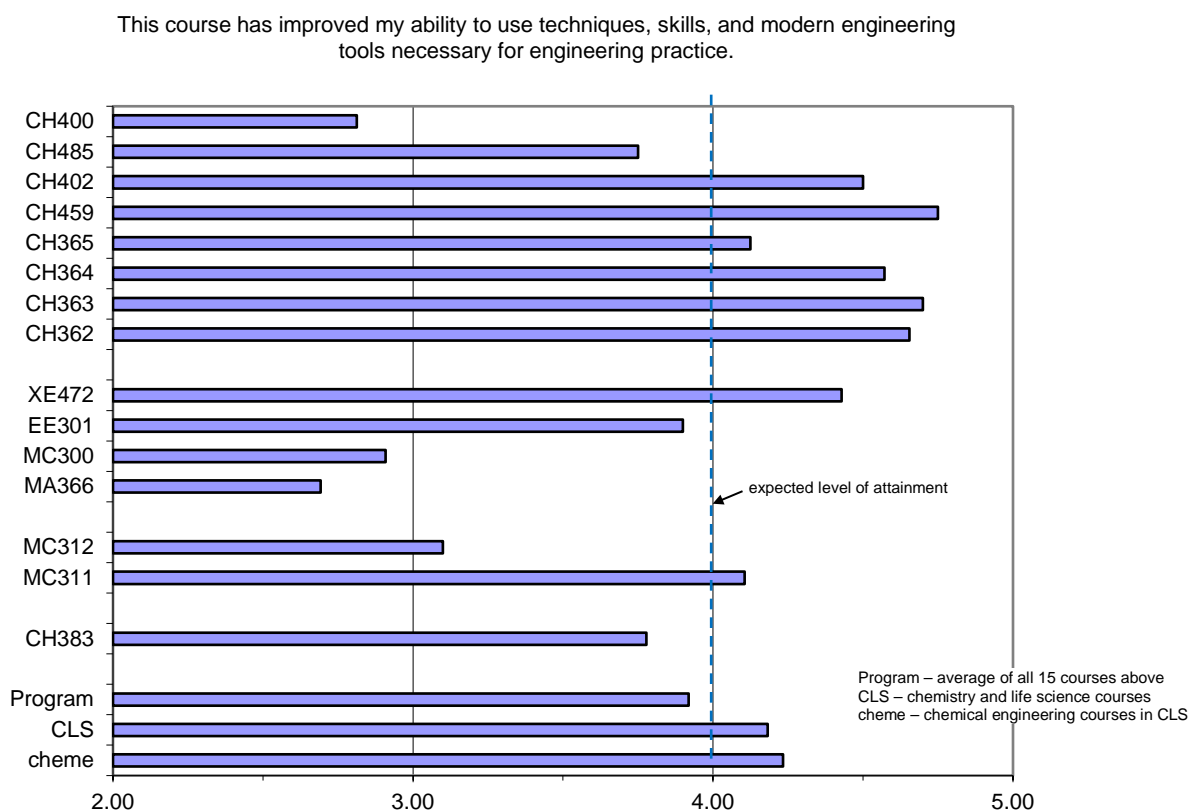


Figure 11-2. End-of-Semester Student Survey responses for Student Outcome 11.

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.” 16 out of 16 cadets completed the survey. Of those who completed the survey, 8/16 cadets replied that they strongly agreed (score = 5/5), 7/16 replied that they agreed (score = 4/5), and 1/16 was neutral (score = 3/5). This equates to a mean score of 4.438/5.00 for the 16 cadets. The expected level of attainment on this survey is 4.00/5.00.

Level of Achievement of Student Outcome 12:

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

- (12.1) General, organic, physical, and analytical chemistry.
- (12.2) Material and energy balances on chemical processes, including safety and environmental factors.
- (12.3) Thermodynamics of physical and chemical equilibria.
- (12.4) Heat, mass, and momentum transfer.
- (12.5) Chemical reaction engineering.
- (12.6) Continuous and staged separation operations.
- (12.7) Process dynamics and control.
- (12.8) Modern experimental and computing techniques.
- (12.9) Process design.

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 4-14. For the Class of 2017, the breakdown by topic is shown in comparison to the national averages.

Subject	Outcome	Questions	USMA ChE	National (expected level of attainment)
Chemistry	12.1	8	11.3	10.3
Material & Energy Balances	12.2	8	9.5	9.3
Safety, Health, & Environmental	12.2	5	8.2	9.3
Thermodynamics	12.3	8	9.1	9.2
Heat Transfer	12.4	8	10.4	9.6
Fluid Mechanics/Dynamics	12.4	8	8.8	9.2
Chemical Reaction Engineering	12.5	8	10.2	9.4
Mass Transfer & Separations	12.6	8	9.7	9.4
Process Control	12.7	5	8.5	9.4
Computational Tools	12.8	4	9.3	9.9
Process Design & Economics	12.9	8	9.8	9.8

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

Chemical Engineering Student Outcome 12										
Course ↓		Advanced Chemistry	Mater. & Energy Bal.	Thermodynamics	Transport	Reaction Engineering	Separations	Dynamics & Control	Process Design	Experiment & Compute
		12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	12.9
CH383	Organic Chemistry I	3.15								
CH365	Chem. Eng. Thermo.			3.65						
CH362	Mass & Energy Balances		3.21							
CH363	Separation Processes						3.31			
CH364	Chem. Reaction Eng.					3.31				
CH459	Chem. Eng. Laboratory									3.54
CH485	Heat and Mass Transfer				2.79					
CH400	Chemical Engineering Sem.			4.00		4.00	4.00	4.00		
CH402	Chem. Eng. Process Des.								2.73	
MA366	Vector Calculus									
ME311	Thermal-Fluid Systems I			3.60	3.60					
ME312	Thermal-Fluid Systems II			3.35	3.35					
CE300	Fund. Eng. Mech. & Des.									
EE301	Intro. To Elec. Engineering									
XE472	Dyn. Modeling & Control							2.63		
Average Grade 2017		3.15	3.21	3.65	3.25	3.66	3.67	3.31	2.73	3.54
Average Grade 2016		3.19	3.57	3.43	3.32	3.64	3.57	3.55	3.43	3.70
Average Grade 2015		3.33	3.63	3.43	3.33	3.72	3.71	3.60	3.40	3.67
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
<i>Previous 5-year Running Average</i> <i>(expected level of attainment)</i>		3.28	3.58	3.49	3.49	3.54	3.57	3.56	3.50	3.69
Standard Deviation 2017		0.84	0.71	0.43	0.47	0.47	0.52	0.57	0.73	0.30

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.	5.00 ± 0.00
2. Design and conduct experiments, as well as analyze and interpret data.	4.60 ± 0.55
3. Design a system, component, or process to meet desired needs within economic, environmental, social, political, ethical, health and safety, manufacturing, and sustainability constraints.	4.20 ± 0.45
4. Function on multidisciplinary teams.	4.40 ± 0.89
5. Identify, formulate, and solve engineering problems.	4.80 ± 0.45
6. Understand professional and ethical responsibilities.	4.20 ± 0.84
7. Communicate effectively.	4.00 ± 0.71
8. Understand the impact of engineering solutions in a global economic, environmental, and societal context.	4.20 ± 0.84
9. Recognize the need and develop the skills required for life-long learning.	4.60 ± 0.55
10. Demonstrate knowledge of contemporary issues.	4.20 ± 0.84
11. Demonstrate an ability to use techniques, skills, and modern engineering tools necessary for engineering practice.	4.60 ± 0.55
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.	4.80 ± 0.45
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.	5.00 ± 0.00
2. Design and conduct experiments, as well as analyze and interpret data.	4.60 ± 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.	4.80 ± 0.42
4. Function on multidisciplinary teams.	4.90 ± 0.32
5. Identify, formulate, and solve engineering problems.	4.90 ± 0.32
6. Understand professional and ethical responsibilities.	5.00 ± 0.00
7. Communicate effectively.	4.50 ± 0.53
8. Understand the impact of engineering solutions in a global economic, environmental, and societal context.	4.70 ± 0.48
9. Recognize the need and develop the skills required for life-long learning.	4.90 ± 0.32
10. Demonstrate knowledge of contemporary issues.	4.90 ± 0.32
11. Demonstrate an ability to use techniques, skills, and modern engineering tools necessary for engineering practice.	4.90 ± 0.32
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.	5.00 ± 0.00
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.	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.	4
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	