Institutional Effectiveness
2022-2023

Program: Chemical Engineering BSCHE
College and Department: College of Engineering, Chemical Engineering
Contact: Dr. Robby Sanders
Mission:

The Department of Chemical Engineering at Tennessee Technological University strives to develop the 21st Century Renaissance Engineer through development and implementation of novel learning environments anchored by the award-winning Renaissance Foundry Model. The foundation of this platform is rooted in the guidelines provided by the National Academy of Engineering's Vision for the Engineer of 2020. Educational protocols within the department are consistent with the mission and vision statements given below:

Mission: The Mission of the Department of Chemical Engineering is to prepare relevant and adaptive chemical engineers in state-of-the-art areas by emphasizing real-world problem solving and critical thinking skills.

Vision: The Vision of the Department of Chemical Engineering is to be a recognized leader in chemical engineering education through excellence in teaching, research, and service.

Attach Curriculum Map (Educational Programs Only):
Attached Files: See Appendix 1

PO1: Real-World Problem Solvers

Define Outcome:
The graduates of our program will obtain positions such as plant process engineer, design engineer, group leader, production engineering, sales engineer.

Assessment Methods:
Student learning outcomes 1-7 are mapped to Program Goal 1, so the same assessment methods communicated for the SLO's apply here. In addition, LinkedIn profiles of alumni often contain position titles.

Criteria for Success (Thresholds for Assessment Methods):

1. Student learning outcomes are met.
2. Position titles are aligned with those of real-world problem solvers.

Link to 'Tech Tomorrow' Strategic Plan:
1.A Experiential Learning,4.E Economic Development

Results and Analysis:
Please refer to results shared for student learning outcomes 1-7.

Also, regarding positions held by CHE graduates, an exploration of job titles continues to indicate good alignment with real-world problem solving.

Use of Results to Improve Outcomes:
No actions are currently planned.

PO2: Critical Thinkers

Define Outcome:
The graduates of our program will demonstrate that they consistently make informed decisions through a process wherein they utilize critical thinking skills.

Assessment Methods:
Student learning outcomes 1, 2, 4, 6, and 7 are mapped to Program Goal 2, so the same assessment methods communicated for the SLO's apply here. In addition, the California Critical Thinking Skills Test (CCTST) is used as the exit exam at the university.

Criteria for Success (Thresholds for Assessment Methods):

1. Student learning outcomes are met.

Link to 'Tech Tomorrow' Strategic Plan:
3.A Efficiency and Effectiveness

Results and Analysis:
Results (for Critical Thinking) --Program Goal 2 and Student Learning Outcomes 1, 2, and 6: For 2022-2023, 26 students in CHE took the California Critical Thinking Skills Test (CCTST) with a mean score of 80.7. This score is slightly higher than those from the previous two years (2020-2021: 79.3, n = 56 | 2021-2022: 78.7, n = 31).

Source: https://www.tntech.edu/iare/assessment/criticalthinking.php

In addition, per results from the "Co-Op Employer Survey" discussed in the "Results: Other" section, CHE co-ops continue to demonstrate a high level of competency in critical thinking (Note: A score of 4 or 5 indicates that the employer agrees or strongly agrees, respectively, with the following statement, "Student can identify and respond to needs based upon an understanding of situational context and logistical analysis of relevant information."). In total, 19 CHE students were employed as a co-op in the Fall 2022, the Spring 2023, and/or the Summer 2023 semester(s). The average score from the co-op supervisors as related to critical thinking was 4.5 with only one score of 3.

Use of Results to Improve Outcomes:
Chemical engineering students continue to perform well on the CCTST exam, and employers seem pleased with the demonstrated critical thinking skills of our co-op students. No actions are currently planned in specific response to these outcomes.

PO3: Formal Education

Define Outcome:
Our graduates will demonstrate that they have continued their education beyond the BS through some form of professional development (not necessarily leading to another degree) or will have graduated from a professional school with an MS, PhD, MD, JD or similar degree.

Assessment Methods:
Student learning outcome 7 is mapped to Program Goal 3, so the same assessment methods communicated for this SLO applies here. In addition, completion of the FE and related professional exams provide indications of a commitment to lifelong learning.

Criteria for Success (Thresholds for Assessment Methods):

1. Student learning outcome is met.
2. Students/graduates complete the FE (or related) exam.

Link to 'Tech Tomorrow' Strategic Plan:
1.A Experiential Learning

Results and Analysis:
Completion of the "Fundamentals of Engineering Exam" (the FE Exam) generally after the BS degree is conferred is one indicator of students continuing their education. In official reports that are generally received bi-annually, two designations are made: 1) those who have completed the exam within 12 months of graduation and 2) those completing the exam >12 after graduation. For the 2022-2023 reporting period, all three TTU CHE students taking the FE Exam received a passing score. One of these took the exam >12 months after graduation, and two others completed the exam within 12 months of graduation.

Use of Results to Improve Outcomes:
As completion of the FE Exam is not a requirement in our program, most of our students/ graduates do not choose to take the exam. As such, the sample size corresponding to the data presented here for CHE is small. Accordingly, no action is currently planned as related to this PO though it will be helpful to consider more ways that this PO can be assessed and to discuss each of the department's PO's with all stakeholders of the department. For example, there are several graduates who have completed or are currently enrolled in medical school programs, and these numbers and types of programs will be summarized in a future reporting period.

PO4: Working at the Frontiers in CHE

Define Outcome:
Graduates from our program will utilize and apply technologies such as biomaterials, nano- and micro-systems, multi-scale analysis, informatics, group dynamics, and multi-media.

Assessment Methods:
Student learning outcomes 1-7 are mapped to Program Goal 4, so the same assessment methods communicated for the SLO's apply here.

Criteria for Success (Thresholds for Assessment Methods):

1. Student learning outcomes are met.

Link to 'Tech Tomorrow' Strategic Plan:
4.E Economic Development

Results and Analysis:
Please refer to results shared for student learning outcomes 1-7.

Use of Results to Improve Outcomes:
No actions are currently planned.

SLO1: Formulate and Solve

Define Outcome:

Formulate and Solve - an ability to identify, formulate and solve complex engineering problems by applying principles of engineering, science, and mathematics.

Assessment Methods:

1. Senior Survey (Annually). The senior survey provides the opportunity for student feedback (anonymously) on different aspects of the program student outcomes, the CHE curriculum, and the student's experiences while at TTU. In addition, a number of questions are directly related to specific SLOs. In this way, feedback is gathered from the student sector of our constituency on both student outcomes and program educational objectives
    a. (Likert≤3)
2. Course-Level Assessments: (Every term a course is taught). The Department uses selected courses to learn about student performance at the different levels of the curriculum, refer to the current "Articulation Matrix" table. Course-level assessment is done every term in which the course is taught, and an Overview is assembled every third year. Those overviews are used to continuously improve the course and curriculum as a whole and are discussed with the departmental faculty and appropriate actions taken.
    a. CHE 4060/4061 Kinetics (≤ 70%) *
    b. CHE 4540 Controls (≤ 70%)
3. Co-Op Employer Assessments: (Semi or annually). The Department uses a survey report directly completed by the students' supervisor at the co-op site to learn about important student competences. The questionnaire requires responses related to each of the 1 through 7 student outcomes.
    a. (Likert≤3)

*Note: Effective with the Fall 2022 semester, the CHE 4210 course with lab (4 credits total) was divided into a lecture section (3 credits) and a lab section (1 credit) which are numbered CHE 4060 and CHE 4061, respectively.

Criteria for Success (Thresholds for Assessment Methods):

1. Senior Survey
    a. A population of seniors is surveyed once every third year.
        i. Likert ≥3/5
2. Course-Level Assessments
    a. Course-Level Assessments are completed for select courses every term in which they are offered
        i. >60% (>70%)
3. Co-Op Employer Assessments

a. Co-Op employer assessment data is gathered for every student participating in co-op at the end of their internship. The collective data is evaluated every third year.
    i. Likert ≥3/5

Link to 'Tech Tomorrow' Strategic Plan:

2.A Technology Infused Programs,3.A Efficiency and Effectiveness

Results and Analysis:

SLO1: FORMULATE & SOLVE – an ability to identify, formulate and solve complex engineering problems by applying principles of engineering, science and mathematics

Assessment Process		**2022-2023**
(threshold Student Outcome attainment level)		
Senior Survey (Goal ≥ 3) ^		**4.2 (n=31)**
Course-Level Assessments	CHE 4060/61 Kinetics (Goal ≥ 70%)	*
	CHE 4540 Controls (Goal ≥ 70%)	
Co-Op Employer Assessments (Goal ≥ 3) #		**4.2**

Notes:

^For the Senior Survey, among other items, students indicate their level of satisfaction on the achievement of each of the seven SLO's choosing one from the following options: Excellent, Very Good, Average, Less than Average, and Poor. Scores of 5, 4, 3, 2, and 1 are assigned to each of these, respectively. The goal is that no individual score is less than 3 which corresponds to Average. There were 31 student responses regarding this outcome for 2022-2023 with scores as follows: Excellent (12), Very Good (14), and Average (5).

[#]None of the employer scores of student's co-op performance as related to this SLO were below 3 for 2022-2023 (Summer-Fall-Spring).

*Results are not available.

The green shading represents that the value meets threshold (i.e., is at or above the goal).

Use of Results to Improve Outcomes:
Significant efforts to better formalize and integrate the lab-based activities with the lecture for CHE 4060/61 (as well as other classes as described in subsequent sections) are being pursued. This is expected to lead to a better articulation of lab activities resulting in increased ability of students to formulate and solve complex, real-world engineering problems.

SLO2: Design for Need, Safety, Global and Social Factors

Define Outcome:

Design for Need, Safety, Global and Social Factors - an ability to apply engineering design to produce solutions that meet specific needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.

Assessment Methods:

1. Senior Survey (Annually). The senior survey provides the opportunity for student feedback (anonymously) on different aspects of the program student outcomes, the CHE curriculum, and the student's experiences while at TTU. In addition, a number of questions are directly related to specific SLOs. In this way, feedback is gathered from the student sector of our constituency on both student outcomes and program educational objectives
    a. (Likert≤3)
2. Course-Level Assessments: (Every term a course is taught). The Department uses selected courses to learn about student performance at the different levels of the curriculum, refer to the current "Articulation Matrix" table. Course-level assessment is done every term in which the course is taught, and an Overview is assembled every third year. Those overviews are used to continuously improve the course and curriculum as a whole and are discussed with the departmental faculty and appropriate actions taken.
    a. CHE 3550/3551 Trans. Sci. II (≤ 70%) **
    b. CHE 4410 Design I (≤ 70%)
    c. CHE 4420 Design II (≤ 70%)
3. Co-Op Employer Assessments: (Semi or annually). The Department uses a survey report directly completed by the students' supervisor at the co-op site to learn about important student competences. The questionnaire requires responses related to each of the 1 through 7 student outcomes.
    a. (Likert≤3)

**Note: Effective with the Spring 2022 semester, the CHE 3121 course with lab (4 credits total) was divided into a lecture section (3 credits) and a lab section (1 credit) which are numbered CHE 3550 and CHE 3551, respectively.

Criteria for Success (Thresholds for Assessment Methods):

1. Senior Survey
    a. A population of seniors is surveyed once every third year.
        i. Likert ≥3/5
2. Course-Level Assessments

    a. Course-Level Assessments are completed for select courses every term in which they are offered
        i. >60% (>70%)
3. Co-Op Employer Assessments
    a. Co-Op employer assessment data is gathered for every student participating in co-op at the end of their internship. The collective data is evaluated every third year.
        i. Likert ≥3/5

Link to 'Tech Tomorrow' Strategic Plan:

2.A Technology Infused Programs,3.A Efficiency and Effectiveness

Results and Analysis:

SLO2: DESIGN for NEED, SAFETY, GLOBAL & SOCIAL FACTORS – an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors

Assessment Process (threshold Student Outcome attainment level)		**2022-2023**
Senior Survey (Goal ≥ 3) ^		**4.1 (n=31)**
Course-Level Assessments	CHE 3550/51 TS II (Goal ≥ 70%)	**73%**
	CHE 4410 Design I (Goal ≥ 70%)	**85%**
	CHE 4420 Design II (Goal ≥ 70%)	**89%**
Co-Op Employer Assessments (Goal ≥ 3) #		**4.3**

Notes:

[^]There were 31 student responses regarding this outcome for 2022-2023 with scores as follows: Excellent (10), Very Good (15), and Average (6).

[#]None of the employer scores of student's co-op performance as related to this SLO were below 3 for 2022-2023 (Summer-Fall-Spring).

The green shading represents that the value meets threshold (i.e., is at or above the goal). Quantitative results reported here for CHE 3550/51 are based on student performance in the CHE 3551 labs. The attached manuscript details changes in the labs for the Spring 2023 semester that reflect the integration of the "Engineering for One Planet Framework" (EOP Framework[1]) and the use of the Renaissance Foundry Model, requiring student teams "to address societal challenges as learning outcomes." This integration resulted in increases in numerous indicators related to SLO2 and associated with the EOP Framework including design, social responsibility, responsible business and economy, environmental impact assessments, and environmental literacy.

Outcomes from the fluids course (CHE 3550) and the design courses (CHE 4410/4420) for the 2022-2023 reporting period are detailed in the respective CLACIR's that are on-file in the department.

Use of Results to Improve Outcomes:

Worksheets have been developed that will be further modified and used during the Spring 2024 offering of CHE 3551 to support lab-based activities. Many of these activities leverage engineering equipment, knowledge of which supports an understanding of design.

SLO3: Communicate

Define Outcome:

Communicate - an ability to communicate effectively with a range of audiences

Assessment Methods:

1. Senior Survey (Annually). The senior survey provides the opportunity for student feedback (anonymously) on different aspects of the program student outcomes, the CHE curriculum, and the student's experiences while at TTU. In addition, a number of questions are directly related to specific SLOs. In this way, feedback is gathered from the student sector of our constituency on both student outcomes and program educational objectives
    a. (Likert≤3)
2. External Review of Senior (Capstone) Design Projects (Annually). External evaluators are invited to assess the quality of Senior Design Projects and to provide feedback on the capstone Design course. The evaluators ask questions of the team members and provide feedback on the technical quality of the projects and oral presentations using an established ABET Criteria-based rubric.
    a. (team average ≤ 70%)
3. Course-Level Assessments: (Every term a course is taught). The Department uses selected courses to learn about student performance at the different levels of the curriculum, refer to the current "Articulation Matrix" table. Course-level assessment is done every term in which the course is taught, and an Overview is assembled every third year. Those overviews are used to continuously improve the course and curriculum as a whole and are discussed with the departmental faculty and appropriate actions taken.
    a. CHE 3550/3551 Trans. Sci. II (≤ 70%) **
    b. CHE 4060/4061 Kinetics (≤ 70%) *
    c. CHE 4240 Capstone Lab (≤ 70%)
    d. CHE 4410 Design I (≤ 70%)
    e. CHE 4420 Design II (≤ 70%)
    f. CHE 4540 Controls (≤ 70%)
4. Co-Op Employer Assessments: (Semi or annually). The Department uses a survey report directly completed by the students' supervisor at the co-op site to learn about important student competences. The questionnaire requires responses related to each of the 1 through 7 student outcomes.
    a. (Likert≤3)

**Note: Effective with the Spring 2022 semester, the CHE 3121 course with lab (4 credits total) was divided into a lecture section (3 credits) and a lab section (1 credit) which are numbered CHE 3550 and CHE 3551, respectively. *Note: Effective with the Fall 2022 semester, the CHE 4210 course with lab (4 credits total) was divided into a lecture section (3 credits) and a lab section (1 credit) which are numbered CHE 4060 and CHE 4061, respectively.

Criteria for Success (Thresholds for Assessment Methods):

1. Senior Survey
    a. A population of seniors is surveyed once every third year.
        i. Likert ≥3/5
2. External Review of Senior (Capstone) Design Projects
    a. Design II projects are externally assessed in the Spring of each year.
        i. >60% (>70%)
3. Course-Level Assessments
    a. Course-Level Assessments are completed for select courses every term in which they are offered
        i. >60% (>70%)
4. Co-Op Employer Assessments
    a. Co-Op employer assessment data is gathered for every student participating in co-op at the end of their internship. The collective data is evaluated every third year.
        i. Likert ≥3/5

Link to 'Tech Tomorrow' Strategic Plan:

1.A Experiential Learning,2.A Technology Infused Programs,3.A Efficiency and Effectiveness

Results and Analysis:

SLO3: COMMUNICATE – an ability to communicate effectively with a range of audiences

Assessment Process (threshold Student Outcome attainment level)		**2022-2023**
Senior Survey (Goal ≥ 3) ^		**4.3**
External Assessment of Capstone Labs (team average ≥ 70%)		
Course-Level Assessments	CHE 3550/51 TS II (Goal ≥ 70%)	**93%**

	CHE 4060/61 Kinetic (Goal ≥ 70%)	*
	CHE 4250 Capstone Lab (Goal ≥ 70%)	+
	CHE 4410 Design I (Goal ≥ 70%)	**90%**
	CHE 4420 Design II (Goal ≥ 70%)	**89%**
	CHE 4540 Controls (Goal ≥ 70%)	
Co-Op Employer Assessments (Goal ≥ 3) [#]		**4.3**

Notes:

[^]There were 31 student responses regarding this outcome for 2022-2023 with scores as follows: Excellent (17), Very Good (7), and Average (7).

[#]None of the employer scores of student's co-op performance as related to this SLO were below 3 for 2022-2023 (Summer-Fall-Spring).

*Results are not available.

The green shading represents that the value meets threshold (i.e., is at or above the goal). As described in the previous results section, a change was made in the CHE 3550 fluids labs for the Spring 2023 semester that reflect the integration of the "Engineering for One Planet Framework" (EOP Framework[1]) and the use of the Renaissance Foundry Model, requiring student teams "to address societal challenges as learning outcomes." This integration resulted in increases in communication and teamwork with the percentage of students performing as excellent on these outcomes increasing from 50% to 93%.

Student teams continue to perform well in presenting their design projects during the Spring semester Design Showcase in the College of Engineering. Outcomes from the design courses (CHE 4410/4420) for the 2022-2023 reporting period are detailed in the respective CLACIR's that are on-file in the department.

+Yellow shading represents a “watch, possibly act” situation.

Use of Results to Improve Outcomes:

The extent to which communication skills should be formally assessed in each of the courses listed in the table immediately above should be discussed in the department. Efforts to identify external sponsors for capstone teams should be pursued to support a wider range of project focus areas.

SLO4: Ethics

Define Outcome:

Ethics - an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgements, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.

Assessment Methods:

1. Senior Survey (Annually). The senior survey provides the opportunity for student feedback (anonymously) on different aspects of the program student outcomes, the CHE curriculum, and the student's experiences while at TTU. In addition, a number of questions are directly related to specific SLOs. In this way, feedback is gathered from the student sector of our constituency on both student outcomes and program educational objectives
    a. (Likert≤3)
2. Course-Level Assessments: (Every term a course is taught). The Department uses selected courses to learn about student performance at the different levels of the curriculum, refer to the current "Articulation Matrix" table. Course-level assessment is done every term in which the course is taught, and an Overview is assembled every third year. Those overviews are used to continuously improve the course and curriculum as a whole and are discussed with the departmental faculty and appropriate actions taken.
    a. CHE 4420 Design II (≤ 70%)
    b. CHE 4540 Controls (≤ 70%)
3. Co-Op Employer Assessments: (Semi or annually). The Department uses a survey report directly completed by the students' supervisor at the co-op site to learn about important student competences. The questionnaire requires responses related to each of the 1 through 7 student outcomes.
    a. (Likert≤3)

Criteria for Success (Thresholds for Assessment Methods):

1. Senior Survey
    a. A population of seniors is surveyed once every third year.
        i. Likert ≥3/5
2. Course-Level Assessments
    a. Course-Level Assessments are completed for select courses every term in which they are offered
        i. >60% (>70%)
3. Co-Op Employer Assessments

a. Co-Op employer assessment data is gathered for every student participating in co-op at the end of their internship. The collective data is evaluated every third year.
    i. Likert ≥3/5

Link to 'Tech Tomorrow' Strategic Plan:
2.A Technology Infused Programs,3.A Efficiency and Effectiveness

Results and Analysis:
SLO4: ETHICS – an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgements, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts

Assessment Process (threshold Student Outcome attainment level)		**2022-2023**
Senior Survey (Goal ≥ 3) ^		**4.3 (n=31)**
Course-Level Assessments	CHE 4420 Design II (Goal ≥ 70%)	**92%**
	CHE 4540 Controls (Goal ≥ 70%)	
Co-Op Employer Assessments (Goal ≥ 3) #		**4.3**

Notes:
^There were 31 student responses regarding this outcome for 2022-2023 with scores as follows: Excellent (13), Very Good (13), and Average (5).

#None of the employer scores of student's co-op performance as related to this SLO were below 3 for 2022-2023 (Summer-Fall-Spring).

The green shading represents that the value meets threshold (i.e., is at or above the goal). Outcomes from the design courses (CHE 4410/4420) for the 2022-2023 reporting period are detailed in the respective CLACIR's that are on-file in the department.

Use of Results to Improve Outcomes:
No actions are planned.

SLO5: Teams

Define Outcome:

TEAMS - an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks and meet objectives.

Assessment Methods:

1. Senior Survey (Annually). The senior survey provides the opportunity for student feedback (anonymously) on different aspects of the program student outcomes, the CHE curriculum, and the student's experiences while at TTU. In addition, a number of questions are directly related to specific SLOs. In this way, feedback is gathered from the student sector of our constituency on both student outcomes and program educational objectives
    a. (Likert≤3)
2. External Review of Senior (Capstone) Design Projects (Annually). External evaluators are invited to assess the quality of Senior Design Projects and to provide feedback on the capstone Design course. The evaluators ask questions of the team members and provide feedback on the technical quality of the projects and oral presentations using an established ABET Criteria-based rubric.
    a. (team average ≤ 70%)
3. Course-Level Assessments: (Every term a course is taught). The Department uses selected courses to learn about student performance at the different levels of the curriculum, refer to the current “Articulation Matrix” table. Course-level assessment is done every term in which the course is taught, and an Overview is assembled every third year. Those overviews are used to continuously improve the course and curriculum as a whole and are discussed with the departmental faculty and appropriate actions taken.
    a. CHE 4240 Capstone Lab (≤ 70%)
    b. CHE 4420 Design II (≤ 70%)
4. Co-Op Employer Assessments: (Semi or annually). The Department uses a survey report directly completed by the students’ supervisor at the co-op site to learn about important student competences. The questionnaire requires responses related to each of the 1 through 7 student outcomes.
    a. (Likert≤3)

Criteria for Success (Thresholds for Assessment Methods):

1. Senior Survey
    a. A population of seniors is surveyed once every third year.
        i. Likert ≥3/5
2. External Review of Senior (Capstone) Design Projects

    a. Design II projects are externally assessed in the Spring of each year.
        i. >60% (>70%)
3. Course-Level Assessments
    a. Course-Level Assessments are completed for select courses every term in which they are offered
        i. >60% (>70%)
4. Co-Op Employer Assessments
    a. Co-Op employer assessment data is gathered for every student participating in co-op at the end of their internship. The collective data is evaluated every third year.
        i. Likert ≥3/5

Link to 'Tech Tomorrow' Strategic Plan:

1.A Experiential Learning,2.A Technology Infused Programs,3.A Efficiency and Effectiveness

Results and Analysis:

SLO5: TEAMS – an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks and meet objectives

Assessment Process (threshold Student Outcome attainment level)		**2022-2023**
Senior Survey (Goal ≥ 3)^		**4.3**
External Assessment of Capstone Labs (team average ≥ 70%)		
Course-Level Assessments	CHE 4250 Capstone Lab (Goal ≥ 70%)	
	CHE 4420 Design II (Goal ≥ 70%)	**93%**
Co-Op Employer Assessments (Goal ≥ 3)#		**4.5**

Notes:

^There were 31 student responses regarding this outcome for 2022-2023 with scores as follows: Excellent (14), Very Good (11), and Average (6).

#None of the employer scores of student's co-op performance as related to this SLO were below 3 for 2022-2023 (Summer-Fall-Spring).

The green shading represents that the value meets threshold (i.e., is at or above the goal). Outcomes from the design course (CHE 4420) for the 2022-2023 reporting period are detailed in the associated CLACIR that is on-file in the department.

Use of Results to Improve Outcomes:

Students have significant opportunities to work in teams on projects throughout the curriculum, and such efforts will continue.

SLO6: Experiment, Analyze, and Interpret

Define Outcome:

Experiment, Analyze, and Interpret - an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgement to draw conclusions.

Assessment Methods:

1. Senior Survey (Annually). The senior survey provides the opportunity for student feedback (anonymously) on different aspects of the program student outcomes, the CHE curriculum, and the student's experiences while at TTU. In addition, a number of questions are directly related to specific SLOs. In this way, feedback is gathered from the student sector of our constituency on both student outcomes and program educational objectives
    a. (Likert≤3)
2. External Review of Senior (Capstone) Design Projects (Annually). External evaluators are invited to assess the quality of Senior Design Projects and to provide feedback on the capstone Design course. The evaluators ask questions of the team members and provide feedback on the technical quality of the projects and oral presentations using an established ABET Criteria-based rubric.
    a. (team average ≤ 70%)
3. Course-Level Assessments: (Every term a course is taught). The Department uses selected courses to learn about student performance at the different levels of the curriculum, refer to the current "Articulation Matrix" table. Course-level assessment is done every term in which the course is taught, and an Overview is assembled every third year. Those overviews are used to continuously improve the course and curriculum as a whole and are discussed with the departmental faculty and appropriate actions taken.
    a. CHE 4060/4061 Kinetics (≤ 70%) *
    b. CHE 4240 Capstone Lab (≤ 70%)

*Note: Effective with the Fall 2022 semester, the CHE 4210 course with lab (4 credits total) was divided into a lecture section (3 credits) and a lab section (1 credit) which are numbered CHE 4060 and CHE 4061, respectively.

Criteria for Success (Thresholds for Assessment Methods):

1. Senior Survey
    a. A population of seniors is surveyed once every third year.
        i. Likert ≥3/5
2. External Review of Senior (Capstone) Design Projects
    a. Design II projects are externally assessed in the Spring of each year.

i. >60% (>70%)

3. Course-Level Assessments
    a. Course-Level Assessments are completed for select courses every term in which they are offered
        i. >60% (>70%)

Link to 'Tech Tomorrow' Strategic Plan:

1.A Experiential Learning,2.A Technology Infused Programs,3.A Efficiency and Effectiveness

Results and Analysis:

SLO6: EXPERIMENT, ANALYZE & INTERPRET – an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgement to draw conclusions

<table>
<tr><td colspan="2">Assessment Process

(threshold Student Outcome attainment level)</td><td>2022-2023</td></tr>
<tr><td colspan="2">Senior Survey (Goal ≥ 3)^</td><td>4.1</td></tr>
<tr><td colspan="2">External Assessment of Capstone Labs

(team average ≥ 70%)</td><td></td></tr>
<tr><td rowspan="2">Course-Level Assessments</td><td>CHE 4060/61 Kinetics

(Goal ≥ 70%)</td><td>*</td></tr>
<tr><td>CHE 4250 Capstone Lab

(Goal ≥ 70%)</td><td></td></tr>
</table>

Notes:

^There were 31 student responses regarding this outcome for 2022-2023 with scores as follows: Excellent (11), Very Good (13), and Average (7).

*Results are not available.

The green shading represents that the value meets threshold (i.e., is at or above the goal).

Use of Results to Improve Outcomes:

Students have opportunities to work on experiments in several CHE courses and in particular the many lab-based courses that are a formal part of the curriculum. This said, it has been recognized that the efforts could be better articulated within the department and that a detailed documentation of lab activities and related curricular materials would be helpful in ensuring consistency. Accordingly, significant efforts were dedicated during the summer of 2023 to better identify and formalize lab-based activities in the department. The result is an increasing and continuously improving set of worksheets that will be leveraged across the curriculum. The impact of these efforts will be communicated in future reports.

SLO7: Knowledge Acquisition and Application

Define Outcome:

Knowledge Acquisition - an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Assessment Methods:

1. Senior Survey (Annually). The senior survey provides the opportunity for student feedback (anonymously) on different aspects of the program student outcomes, the CHE curriculum, and the student's experiences while at TTU. In addition, a number of questions are directly related to specific SLOs. In this way, feedback is gathered from the student sector of our constituency on both student outcomes and program educational objectives.
    a. (Likert≤3)
2. Course-Level Assessments: (Every term a course is taught). The Department uses selected courses to learn about student performance at the different levels of the curriculum, refer to the current "Articulation Matrix" table. Course-level assessment is done every term in which the course is taught, and an Overview is assembled every third year. Those overviews are used to continuously improve the course and curriculum as a whole and are discussed with the departmental faculty and appropriate actions taken.
    a. CHE 3550/3551 Trans. Sci. II (≤ 70%) **
    b. CHE 4410 Design I (≤ 70%)
3. Co-Op Employer Assessments: (Semi or annually). The Department uses a survey report directly completed by the students' supervisor at the co-op site to learn about important student competences. The questionnaire requires responses related to each of the 1 through 7 student outcomes.
    a. (Likert≤3)

**Note: Effective with the Spring 2022 semester, the CHE 3121 course with lab (4 credits total) was divided into a lecture section (3 credits) and a lab section (1 credit) which are numbered CHE 3550 and CHE 3551, respectively.

Criteria for Success (Thresholds for Assessment Methods):

1. Senior Survey
    a. A population of seniors is surveyed once every third year.
        i. Likert ≥3/5
2. Course-Level Assessments
    a. Course-Level Assessments are completed for select courses every term in which they are offered
        i. >60% (>70%)
3. Co-Op Employer Assessments

a. Co-Op employer assessment data is gathered for every student participating in co-op at the end of their internship. The collective data is evaluated every third year.
    i. Likert ≥3/5

Link to 'Tech Tomorrow' Strategic Plan:

2.A Technology Infused Programs,3.A Efficiency and Effectiveness

Results and Analysis:

SLO7: KNOWLEDGE ACQUISTION & APPLICATION – an ability to acquire and apply new knowledge as needed, using appropriate learning strategies

Assessment Process (threshold Student Outcome attainment level)		**2022-2023**
Senior Survey (Goal ≥ 3) ^		**4.2**
Course-Level Assessments	CHE 3550/51 TS II (Goal ≥ 70%)	**76%**
		78%
	CHE 4410 Design I (Goal ≥ 70%)	**78%**
Co-Op Employer Assessments (Goal ≥ 3) #		**4.5**

Notes:

^There were 31 student responses regarding this outcome for 2022-2023 with scores as follows: Excellent (13), Very Good (12), Average (5), and Less than Average (1).

#None of the employer scores of student's co-op performance as related to this SLO were below 3 for 2022-2023 (Summer-Fall-Spring).

The green shading represents that the value meets threshold (i.e., is at or above the goal).

The top number for CHE 3550/51 is based on assessments of student projects in the fluids-related lab sections (CHE 3551) as associated with this SLO while the bottom number corresponds to the average exam scores from the three exams during the semester (CHE 3550). In the context of a holistic strategy, performance on these exams is one way that students demonstrate their ability "to acquire and apply new knowledge" as indicated by ABET for this SLO. The percentage of exams completed with a score less than the 70% threshold goal was 24% in 2023.

Outcomes from the design course (CHE 4420) for the 2022-2023 reporting period are detailed in the associated CLACIR that is on-file in the department.

Use of Results to Improve Outcomes:

No actions are planned.

Summative Evaluation:
Chemical engineering students continue to provide generally positive feedback regarding their experiences in the program, and the evaluations completed by supervisors of TTU CHE students who participate in co-op reflect very favorably on their performance. Likewise, TTU CHE student performance on the California Critical Thinking Skills Test, which serves as the university's senior exit exam, continues to be strong. A recognized need to increase hands-on learning experiences is being addressed through the development and continuous improvement of worksheets and related lab activities with a goal to establish a seamless lecture-lab integration.

Assessment Plan Changes:
There are currently no plans to change the assessment approach though this needs to be carefully considered in future reporting periods as changes in available personnel occur.

List of Appendices:
Appendix 1: Curriculum Map

Appendix 1: Curriculum Map

Mapping of Student Outcomes and Program Educational Objectives

	Program Educational Objectives			
Student Outcomes	**Real World Problems Solver (RWPS)**	**Critical Thinker (CT)**	**Continue Formal Education (CFE)**	**Work at Frontiers in Chemical Engineering (FChE)**
1 Formulate	X	X		X
2 Design	X	X		X
3 Communicate	X			X
4 Ethics	X	X		X
5 Teams	X			X
6 Experiment	X	X		X
7 Knowledge	X	X	X	X

Articulation Matrix for the period beginning May 2020* for purposes of Course-Level Student Outcomes assessment

Course No.	Description	Required or Elective (R or E)	Mapping to Student Outcomes (SO)						
			1 Formulate & Solve	2 Design for Need, Safety, Global & Societal	3 Communicate	4 Ethics in Global & Societal Context	5 Teams	6 Experiment Analyze & Interpret	7 Knowledge Acquisition
CHE 1010	Intro. to CHE	R							
CHE 1020	CHE Process., Prod. & Ethics	R							
CHE 2015	Chem and Biol Eng. Analysis I	R							
CHE 2020	Chem and Biol Eng. Analysis II	R							
CHE 3010	Thermo of Chem. Proc.	R							
CHE 3050/51	Cond., Rad., Diff. w/Lab	R							
CHE 3735	CHE Operations	R							
CHE 3510/11	CHE Thermodynamics II w/Lab	R							
CHE 4050/51	Diff. & Mass Transfer w/Lab	R							
CHE 3550/51*	**TS II: Fluid Mechanics w/Lab****	**R**		**ABET**	**ABET**				**ABET**
CHE 4060/61*	**Chemical Reaction Engineering w/Lab****	**R**	**ABET**		**ABET**			**ABET**	
CHE 4250	**ChE Capstone Laboratory**	**R**			**ABET**		**ABET**	**ABET**	
CHE 4410	**Process Design I**	**R**		**ABET**	**ABET**				**ABET**
CHE 4420	**Process Design II**	**R**		**ABET**	**ABET**	**ABET**	**ABET**		
CHE 4540	**Process Dynamics & Controls**	**R**	**ABET**		**ABET**	**ABET**			

1	Red	(255, 0, 0)
2	Blue	(0, 112, 192)
3	Orange	(255, 192, 0)
4	Purple	(112, 48, 160)
5	Orange, Accent 6	(247, 150, 70)
6	Yellow	(255, 255, 0)
7	Light Green	(146, 208, 80)

ABET – Assessed Student Outcome for ABET continuous improvement purposes, courses shown in **bold**.

*The table has been updated to reflect changes (effective 2022) in course numbers.

**Assessment of lab-related outcomes is documented in the CLACIR.