

UNIT REPORT

**Chemistry BS - Final Annual
Report**

CHMA: The A.C.S. concentration is intended to prepare students for graduate school or to pursue chemistry as a profession in industry.

CHMP: The CHMA concentration was renamed CHMP in 2008 (Pure Chemistry), in part due to the changes made by the American Chemical Society for certification of degrees since ACS dissolved each of its degree programs and asked

found in the ACS Chemistry concentration. An integral part of this program is a minimum of one year of cooperative employment experience.

f. Chemistry – This option maintains the flexibility of the current program, allowing adaptation to new areas of interest as they develop.

CHMB: The Biochemistry concentration is intended to serve pre-professional students and those who wish to pursue graduate work at the chemistry-biology interface.

Update: Only superficial changes were made to this program as a result of the new certification requirements of the American Chemical Society. This degree remains basically the same as it was in 2005.

Outcome 1: Mastery of Factual Knowledge

Define Goal:

Senior chemistry majors in all three concentrations will be able to demonstrate a **mastery of factual knowledge** comprehensively across the five principal areas of chemistry (organic, inorganic, physical, analytical and biochemistry), and be able to analyze and solve problems, understand relationships, and interpret scientific facts and data. cohort = CHMA(CHMP), CHMB, CHMN

Outcome 2: High Level of Critical Thinking

Progress: Ongoing

Define Goal:

Senior chemistry majors in all three concentrations will be able to demonstrate a high level of **critical thinking** and reasoning ability within the context of the chemical discipline. cohort = CHMA(CHMP), CHMB, CHMN

Outcome 3: Mastery of Modern Factual Knowledge in Biochemistry

Progress: Ongoing

Define Goal:

Senior chemistry majors in the biochemistry concentration will be able to demonstrate a **mastery of** modern factual knowledge in the **biochemistry** sub-discipline. cohort = CHMB

Outcome 4: Demonstrate Computer Proficiency

Progress: Ongoing

Define Goal:

Senior Chemistry majors in all concentrations will be able to **access computers** and **demonstrate proficiency** in using computers **to solve problems in chemistry**. cohort = CHMP, CHMB, CHMN.

Outcome 5: Successful matriculation to Industry, Graduate and Professional Health Science Schools

Progress: Ongoing

Define Goal:

Chemistry BS Graduates will be successful in gaining entrance into **high quality graduate schools** in chemistry, admission to **professional schools**, and securing **quality careers** in the chemical sciences. cohort = CHMP, CHMB, CHMN

Outcome 6: Integrate Chemical Knowledge with Research & Team-Based Learning

Progress: Ongoing

Define Goal:

Senior chemistry majors will be able to demonstrate ability to **integrate chemical knowledge** in the successful conduct of **undergraduate research projects** as well as work well in **team-based research** by graduation. cohort =CHMP, CHMB, CHMN.

Outcome 7: CHEM 1110/1120 ACS Exam Score Improvement

Progress: Ongoing

Define Goal:

Students completing the main sequence general chemistry CHEM1110/1120 will be able to **demonstrate a thorough knowledge of general chemistry** as evidenced by **exceeding the average score** on the **National ACS General Chemistry Exam** or professionally equivalent exams.

Program Goal 1: Increase External Funding

Progress: Ongoing

Define Goal:

Increase external funding by 5% per year to improve quality of research.

Program Goal 2: Chemistry Department Advisory Board Growth and Utilization Expansion

Progress: Ongoing

Define Goal:

Establish and strategically expand the Chemistry Department Advisory Board

Assessment: ACS National & Internally Generated General Chemistry Exams

Goal/ Outcome/ Objective: Outcome 7

Type of Tool: National Accrediting Agency Requirements and Standards

Frequency of Assessment: Annual

Rationale:

The **National ACS General Chemistry exam**, purchased from the ACS-CPT and given to all of our students in CHEM 1120 each Spring semester, is useful since it contains the scores of hundreds of students from a large number of Universities nationwide. Results are shared with faculty and discussed at faculty meetings and retreats. Comparable professionally equivalent, internally generated common exams are also created and in those cases, student improvement is based on year-to-year performance.

Assessment: Chemistry Department Annual Report

Goal/ Outcome/ Objective: Outcome 5 & 6, Program goals 1 & 2

Type of Tool: Annual Unit Report

Frequency of Assessment: Annual

Rationale:

Matriculation to **graduate** and **professional schools** as well as the **number of students conducting research** during the academic year and/or

Chemistry Department Advisory Board growth, expansion and utilization is also tabulated in the department's annual report as well as discussed at faculty meetings and/or retreats. A Chemistry advisory board (Program Goal 2) will help us with curriculum evolution as well as with targeted fund-raising. Such changes to the curriculum is also discussed at faculty meetings/retreats.

Assessment: ETS Chemistry Field Exam

Goal/ Outcome/ Objective: Outcome 1, 2 & 3

Type of Tool: Exit Exam

Frequency of Assessment: Annual

Rationale:

Student Performance on the national **ETS Chemistry Field Exam** in the four branches of chemistry (referred to as subscores 1 through 4) for Outcome 1. Student performance, Assessment Indicator #2 (Critical Thinking and Reasoning Ability) for Outcome 2. Senior performance on the ETS Chemistry Field Exam -Assessment indicator #1 (Biochemistry knowledge assessment) for Learning Outcome 3.

- This **mastery level** by TTU students on the **ETS Field Exam**, which should exceed the national average for CHMA majors as demonstrated on the ETS Chemistry Field Exam, is discussed at faculty meetings (cohort = CHMA(CHMP), CHMB, CHMN).
- This **mastery level** by TTU students for **critical thinking** and reasoning ability on the ETS Field Exam that should meet or exceed the national average for chemistry majors as demonstrated on the ETS Chemistry Field Exam is discussed with faculty at faculty meetings (cohort =CHMA (CHMP), CHMB, CHMN)
- This **mastery level** by TTU CHMB students on the ETS Field Exam, which should **exceed the national average as demonstrated on the Biochemistry knowledge assessment** of the ETS Chemistry Field Exam, is taken into

Quality of courses in preparing me for employment/graduate school 1 2 3 4 5

Quality of instruction in:

General Chemistry

Organic Chemistry 05(our)-0.3p05(our)-0.30y

Or

Attached Files

[📄 Graduating Senior Survey](#)

Assessment: National Survey of Student Engagement (NSSE)

Goal/ Outcome/ Objective: Outcome 4

Type of Tool: Focus Group

Frequency of Assessment: Annual

Rationale:

Initially the Enrolled Student Survey was used for as an assessment tool, however, that tool was replaced with the NSSE in 2009. This tool is useful to collect information related to computer use by students.

Through monitoring the responses of freshmen and senior chemistry majors where students are asked how often they have worked an assignment where a computer was used, an increase should be observed. Faculty are encouraged at faculty meetings to continue to provide such exercises. cohort =CHMP, CHMB, CHMN.

Assessment: SciFinder Scholar

Goal/ Outcome/ Objective: Program Goal 1

Type of Tool: Other

Frequency of Assessment: Annual

Rationale:

In order to assess our goal of increasing research productivity, SciFinder scholar is us

(Avg F/S)	TTU (Chemistry)	score %ile (institutional avg/individual score average)
2008-2009	146	43/48
2009-2010	145	45/40
2010-2011	147.1	51/46
2011-2012	144	50/43
2012-2013	152	60/60
2013-2014	151	60/60
2014-2015	152	61/63
2015-2016	150	58/61
2016-2017	146	49/39
2017-2018	146	148 (Comparison data is now the national average)

2. This was a new learning outcome in 2005-06 made available by the availability of this Assessment Indicator on the ETS Exam. When compared to 227 other Universities median scores, TTU Chemistry graduates scored in the following national percentiles for critical thinking (2011-2018); 41, 44, 64, 48, 60 and 60, 48 and 40 respectively.

3. While the ETS Chemistry Biochemistry Assessment indicator does not reflect an actual Biochemistry exam, it does incorporate questions which allow assessment of biochemical knowledge, thus, we have tracked these scores between 2007 and 2018. Likely in part due to the nature of this assessment indicator (where questions that relate to Biochemistry and pulled from the four actual sections of the Chemistry exam), our scores have been quite variable. For example, in the Fall of 2006, we scored in the 99 percentile, but in the following Spring (2007) we scored in the 76 percentile. The actual percentiles observed Spring 2009-Spring 2018 are 68, 82, 76, 61, 57, 57, 63, 52, 48 and 54. The ACS Biochemistry exam has been much more reliable as this is an actual Biochemistry exam written by the American Chemical Society. However, only students taking the full year Biochemistry sequence take this exam. Between 2009 and 2018, TTU students scored in the following percentiles; 61, 65, 71, 65, 69, 60, 63, 60, 64 and 65. For a regional, rural university, these are respectable percentiles.

Results: External Funding

Goal/Objective/Outcome Number: Program Goal 1

Results:

The following **table tabulates acquired funding** by the department of Chemistry faculty since 2005. To provide an historical perspective: the four-year total research funding level in the department 1998-2002 was an average of \$121K per year. Our target is a research funding level that increases by 5% per year over the \$121K per year average. We have dramatically exceeded this goal (nearly tripled) as seen in the table below (Ref. Delaware Reports 2005-2006 through 2009-2010 and the Chemistry Annual Reports through 2018).

External Funding Awarded to Departmental Faculty

Academic Year	Total New Awards	Target Level
2006-2007	\$1,037,689	\$126K
2007-2008	\$36,300	\$132K
2008-2009	\$283,013	\$139K
2009-2010	\$103,000	\$146K
2010-2011	\$122,253	\$153K
2011-2012	\$236,957	\$161K
2012-2013	\$94,309	\$169K
2013-2014	\$568,600	\$177K

2014-2015	\$725,046	\$185K
2015-2016	\$1,437,827	\$194K
2016-2017	\$545,294	\$203K
2017-2018	\$950,133	\$213K
Total last 13 years	\$ 6,260,413	\$2,118,000

Results: NSSE

Goal/Objective/Outcome Number: Outcome 4 and Outcome 6

Results:

Below is a compilation using a current assessment metric for 2009 and 2011 offered by the University. This data shows that more and more students in Chemistry are using computers during their tenure at TTU.

Question	Class level	2009		2011	
		N	Mean	N	Mean
Number of problem sets (problem-based homework assignments) that take you MORE than an hour to complete	Freshman (1st year)	12	3.25	7	3.29
	Senior (4th year)	12	2.83	9	3.56
Institutional emphasis: Using computers in academic work	Freshman (1st year)	13	3.46	8	3.75
	Senior (4th year)	12	3.50	9	3.78

NSSE Question (2009 and 2011)	Class Level	2009		2011	
		N	Mean	N	Mean
Practicum, Internship, field experience, co-op or clinical assignment	Freshman (1st Year)	13	3.00	8	2.75
	Senior (4th Year)	11	2.00	9	3.44
Worked with faculty on activities other than coursework outside of class	Freshman (1st Year)	13	1.77	8	1.75
	Senior (4th Year)	12	2.00	8	2.63
Work on a research project with a faculty member outside of class or program requirement	Freshman (1st Year)	13	2.38	8	2.63
	Senior (4th Year)	12	2.83	9	3.00
Culminating senior experience (capstone, senior project, thesis or comprehensive exam)	Freshman (1st Year)	13	2.54	8	2.13
	Senior (4th Year)	12	2.92	9	3.22

Results: Chemistry Department Annual Report Data Excerpts

Goal/Objective/Outcome Number: Outcome 5 & 6 and Program Goal 1

Results:

Outcome 5: A combination of the Chemistry Department Annual Report and the Graduating Student Survey are used to

compile a list of where our students go when they leave TTU. This is tabulated in the attached file as TTU Chemistry B.S. Graduates. Where are they now? Since 2008 we have had students gain entry and successfully matriculate from Universities and Professional Schools throughout the US and the nation. One of our recent graduates just completed his PhD at the University of Chicago and is now a post-doc at Northwestern and three of our Biochemistry graduates just completed medical school at the University of Alabama-Birmingham (UAB). Another chemistry graduate just finished his third year at the University of Virginia Medical School.

Outcome 6: Data from the Chemistry Department Annual Report and ACS National Meeting Programs are used to tabulate the number of active students in research and the number of students presenting their research at national ACS meetings. Since 2007, TTU chemistry has sent either the highest, or the second highest number of undergraduate students to the national ACS meeting to present the results of their research. Since the ESS exam is no longer an available assessment tool, the department has used as a metric the number of students undertaking undergraduate research and the number of students disseminating that research at a national meeting as an assessment indicator. The following table tabulates the participation of undergraduates at the National meeting of the ACS. NSSE data, as well as Graduating Student Surveys also further illustrate the availability of research as seen through the eyes of a subset of freshmen and graduating chemistry majors in 2009 and 2011. Of those that took the NSSE survey in 2009 and 2011, an increase is noticed in the number of upperclassmen planning to conduct some form of undergraduate research demonstrating students are becoming more and more aware of these opportunities.

Academic Year

Meeting	Students Active in Undergrad Research	Research Presented at the National ACS
2017-2018	74	19 (New Orleans, La)
2016-2017	72	15 (San Francisco, Ca)
2015-2016	77	26 (San Diego, Ca)
2014-2015	77	26 (Denver, Co)
2013-2014	72	22 (Dallas, Tx)
2012-2013	71	15 (New Orleans, La)
2011-2012	67	12 (San Diego, Ca)
2010-2011	53	17 (Anaheim, Ca)
2009-2010	40	14 (San Francisco)
2008-2009	41	12 (Salt Lake City)
2007-2008	32	12 (New Orleans)
2006-2007	28	13 (Chicago)
2005-2006	23	9 (Atlanta)

Program Goal 1: Additional tabulated departmental funding results are shown under an additional results tab.

Attachments: Attached Files

[Where are they now 2016](#)

Results: General Chemistry Exam

Goal/Objective/Outcome Number: Outcome 7

Results:

2015	38.7%	59.0%	2015	N/A	N/A
2016	32.7%	18.3%	2016	56.3%	44.4%
2017	42.7%	52.0%	2017	49.8%	34.2%
2018	N/A	N/A	2018	47.0%	35.6%

Modifications and Continuing Improvement: Outcome 1

Goal/Objective/Outcome Number: Outcome 1

Program Changes and Actions due to Results:

For Student Learning Outcome 1, as assessed by the ETS Field exam for student performance in chemistry, the department continues to stress the importance of introducing new pedagogy in the classroom. The department formed an ad hoc committee to develop a platform for enhanced chemistry learning/tutoring through exploitation of desire-2-learn and PenCasts (Chemical Solutions). Laboratory equipment purchased with funds provided to the science departments in the College of Arts and Sciences are used to a greater extent in upper division chemistry classes. Those funds have been used to purchase an FTIR instrument, a Gas Chromatograph, a Raman Spectrometer and an Ion Chromatograph in order to enhance upper division laboratory experiences and undergraduate research. The department recently purchased an evaporative light scattering detector (ELSD) for a liquid chromatograph and a new FT-

also purchased a gel imaging system. These activities will continue as we move forward. External funding has also been sought: Faculty received funding for the purchase of a Bioanalyzer, a PCR machine and a NanoDrop spectrometer from NSF to further enhance these laboratory experiences. A team led by Dr. Carrick was successful obtaining an NSF grant to purchase a new NMR with a cryo-probe. This provides a giant step forward in organic chemistry, inorganic chemistry and biochemistry. In addition, a greater number of students started carrying out undergraduate research during the academic year - oftentimes utilizing this newly acquired instrumentation in their research.

problems with the company, and a lack of student improvement, we switched back to using OWL online homework in General Chemistry. In Fall 2014, in hopes of further improving student success, we moved to the “atoms first” teaching pedagogy as well as an advanced online homework system. More **new experiments were implemented based on modern computer-interfaced instrumentation**, such as the acquisition of the MeasureNet system in General Chemistry (\$100K). The MeasureNet system allows for a greater number of guided-inquiry type experiments furthering the computational experience of TTU students taking Chemistry classes. A new team-taught course in **computational chemistry was added** to the curriculum in 2012 and has continued. The Enrolled Student Survey was abandoned by TTU shortly after 2005-2006. It was replaced by the NSSE survey for which we have 2009 and 2011 data at this time. As a result of the prior ESS data, faculty in the department of Chemistry continued to increase the use of computers in instruction. This has included on-line homework in multiple classes, the requirement of utilizing spreadsheets in general chemistry, and increasing use of computers via on-line literature searches required in multiple classes, etc. We have requested the chemistry student data be pulled from the NSSE 2014 and 2016 data sets in order to assess that data. Additional modifications may result after that data is analyzed.

Link to Flight Plan: Technology in Teaching

Improve Undergraduate Student Experience

Modifications and Continuing Improvement: Outcome 5

Goal/Objective/Outcome Number: Outcome 5

Program Changes and Actions due to Results:

Student Learning Outcome 5, as assessed by a combination of the Chemistry Department Annual Report and the Graduating Student Survey, now addresses all of our concentrations in Chemistry (CHMA, CHMP, CHMB and CHMN) since degree certification requirements changed in 2008. This learning outcome has been successful. **Students from all** of the above **concentrations** are leaving TTU to **attend graduate and professional schools**. In order to further increase the success of our students, we have made **career options more available** to students through expanded board space in

funds for undergraduate research projects, in addition to the **Student Research Development Grants (SRDG)** mentioned in **Learning Outcome VI**. In 2008, the year the SRDG was initiated, \$2,800 was awarded; in 2009, \$5,600 was awarded and in 2010, \$10, 543 was awarded. In Fall 2011, an additional \$4,185 was awarded during the first of four submission dates during the 2011-2012 academic year. Funds awarded during 2012-2013 exceeded \$11,000 as the

been hired and each is required to **vigorously pursue the acquisition of external funding**. During 2013-2014, an interdisciplinary grant application between chemistry and chemical engineering was funded at \$ 475,000 by the