UNIT REPORT

Chemistry MS - Institutional Effectiveness Final Annual Report 2019

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Chemistry MS

Department of Chemistry MS Mission Statement

Reporting Year: 2018-2019

Providing Department: Chemistry MS

Department/Unit Contact: Jeff Boles

Mission/Vision/Goal Statement:

The mission of the graduate program in chemistry may be summarized as follows:
1. To provide an ongoing program of study that prepares graduates to successfully pursue scientific careers in industry or to continue their education in a doctoral program or professional school.
2. To provide students with opportunities to reinforce their background and expand their knowledge in areas integrated with their undergraduate coursework, with course offerings in the five major branches of chemistry.
3. To provide an ongoing, stimulating and intellectual atmosphere conducive to the learning process of both students and faculty through low student-to-faculty ratios.
4. To provide the facilities and professional mentorship enabling students to propose, conduct, evaluate, and report in a systemic way on original research and thereby add to the knowledge of humanity.
5. To provide opportunities for students to refine both oral and written communication skills.

The graduate curriculum is designed to acquaint students with the current ideas in the five major areas of chemistry (organic, inorganic, physical, analytical, and biochemistry). The thesis project affords the student practical experience in the methods used to obtain new knowledge and to develop the skills necessary to understand and relate this knowledge. Special topics courses allow individual professors to present specialized material in their area of expertise. The faculty maintains a wide variety of research programs, giving each student an opportunity to conduct, evaluate, and report on original research.

Outcome 1: Effective Use of Scientific Method

Define Goal:

Students will emerge from the M.S. Chemistry graduate program being able to use the scientific method effectively to solve chemical research problems. Particularly, this includes (but is not limited to the following sub-outcomes).

Students will be able to:

• employ critical thinking skills to analyze a chemical problem, (Assessment Item 12 on M.S. Survey of Graduates, M.S. Survey of Faculty). Surveyed annually and compiled every 5 years.

• collect background information through the effective use of the scientific literature, (Assessment Item 13 on M.S. Survey of Graduates, M. S. Survey of Faculty). Surveyed annually and compiled every 5 years.

• prepare a hypothesis, design and execute experiments to test the hypothesis, keeping complete experimental records, (Assessment Item 14 on M.S. Survey of Graduates, M. S. Survey of Faculty). Surveyed annually and compiled every 5 years.

• apply appropriate statistical analysis to collected research data, (Assessment Item 15 on M.S. Survey of Graduates, M. S. Survey of Faculty). Surveyed every 5 years.

• apply critical thinking skills to further refine the hypothesis based on experimental evidence (Assessment Item 12 on M.S. Survey of Graduates, M.S. Survey of Faculty). Surveyed annually and compiled every 5 years.

Intended Outcomes / Objectives:

Outcome 2: Effectively Communicate Both Orally and Written

Define Goal:

Students will emerge from the M.S. Chemistry graduate program being able to effectively communicate scientific knowledge and ideas through both oral and written communication skills.

Intended Outcomes / Objectives:

Program Goal 1: Increase Level of Research and Scholarly Activity

Define Goal:

To continuously **increase the level of research and scholarly activity** among the faculty by **5% (every 2 years)** in order to engage graduate students in **cutting-edge research activities**.

Intended Outcomes / Objectives:

Program Goal 2: Increase External Funding

Define Goal:

To **increase** external **funding by 5% per year** to **improve quality of instrumentation** necessary for education and research.

Intended Outcomes / Objectives:

Program Goal 3: Decrease Teaching Load of Graduate Faculty

Define Goal:

To **decrease** the traditional classroom **teaching load of Graduate Faculty to 9 contact hours or less** by providing appropriate credit for student research involvement, grant writing, special service work, and other chair-assigned activities.

Intended Outcomes / Objectives:

Program Goal 4: Maintain a Satisfactory Graduation Rate

Define Goal:

The Chemistry M.S. Program will **maintain a level of at least 5 graduates per year**.

Intended Outcomes / Objectives:

Assessment: Chemistry Department Annual Report

Goal/ Outcome/ Objective: Program Goal 1, 2, 3 & 4

Type of Tool: Annual Unit Report

Frequency of Assessment: Annual

Rationale:

Chemistry Department Annual Report (Annually, Outcomes 1-4). Information in the Chemistry Department Annual **Report provides annual tabulation of the results** of each program goal (Indirect, but containing information from Direct Measure Assessment)

We will continue to monitor the graduation rate of the M.S. Chemistry program on the yearly cycle defined to begin with Summer commencement through following Spring commencement. The Chemistry Department Annual Report is used to not only track such data, but is also **disseminated to the faculty and discussed at faculty meetings and retreats**, as are the other assessment tools. The graduate program is assessed by external peer-review every 5 years.

Assessment: Chemistry M.S. Survey of Graduates

Goal/ Outcome/ Objective: Outcome 1 & 2

Type of Tool: Focus Group

Frequency of Assessment: Every year, Every 5 Years

Rationale:

Specific items on this survey (Attached) along with the students Graduate Advisory Committee will assess students' progress on each of the above sub-outcomes.

A student with an advanced degree in chemistry must have sufficient critical thinking and problem solving skills in order to succeed. Graduate Advisory Committees of the graduate students at the time of proposal presentations, literature seminar, thesis seminar, and oral defense of the written thesis will make evaluations of student progress on Learning Outcome 1 and 2. Progress and novel ideas for improvement are discussed within these committees, at faculty retreats and occasionally at faculty meetings. The results of the Chemistry M.S. Survey of Graduates and the Chemistry M.S. Survey of Faculty are also discussed at faculty meetings and retreats since they contain valuable information as a direct measure of assessment.

Attached Files

MS Survey of Graduates

Assessment: Chemistry MS Survey of Faculty

Goal/ Outcome/ Objective: Outcome 1 & 2

Type of Tool: Survey

Frequency of Assessment: Every 5 Years

Rationale:

Specific items on this survey (Attached) will assess students' progress on outcomes 1 and 2.

A student with an advanced degree in chemistry must have sufficient critical thinking and problem solving skills in order to succeed. Graduate Advisory Committees of the graduate students at the time of proposal presentations, literature seminar, thesis seminar, and oral defense of the written thesis will make evaluations of student progress on Learning Outcome 1 and 2. Progress and novel ideas for improvement are discussed within these committees, at faculty retreats and occasionally at faculty meetings. The results of the Chemistry M.S. Survey of Graduates and the Chemistry M.S. Survey of Faculty are also discussed at faculty meetings and retreats since they contain valuable information as a direct measure of assessment.

Attached Files

MS Survey of Faculty

Assessment: Delaware Study and Institutional Research Data

Goal/ Outcome/ Objective: Program Goal 2, 3 & 4

Type of Tool: Tracking Spreadsheet

Frequency of Assessment: Annual

Rationale:

Information in the Delaware Study will be utilized to determine and tabulate the **total amount of external funds activated each year** by the department, the **actual teaching load assigned** by the chair and the number of degrees awarded.

The University must file certain reports each year that indicate levels of funding support acquired from outside sources. The Delaware Report is thus very useful for acquiring this data.

Faculty are consulted by the chair regarding teaching loads and release time needs in order for them to be more productive in research. The chair works with the Dean of Arts & Sciences and analyzes Delaware Reports to **assure** that both the **requirements of the American Chemical Society are met** (regarding teaching loads) and that resources are available to reach that goal.

Assessment: Directory of Graduate Research (DGR) and Scifinder Scholar

Goal/ Outcome/ Objective: Program Goal 1

Type of Tool: Tracking Spreadsheet

Frequency of Assessment: Every other year (biannual)

Rationale:

Assessment of the **number of refereed scholarly publications** will be those listed in the Directory of Graduate Research (DGR). **Historical Note:** For the years prior to 2001, our departmental faculty had an average of 17 per year. A 5% increase per edition beginning with Outcome 1. **Beginning in 2013**, the DGR no longer published the peer-reviewed publications of each faculty member, thus, assessment changed to the utilization of SciFinder Scholar as a direct measure assessment tool.

The Directory of Graduate Research historically provided a national means for comparing productivity in research publication to that of the faculty in TTU Chemistry. Although this data is no longer available, extraction of publications of each faculty member can be accomplished utilizing **SciFinder Scholar**.

Assessment: Graduate Advisory Committees

Goal/ Outcome/ Objective: Outcome 1 and 2

Type of Tool: Focus Group

Frequency of Assessment: Annual

Rationale:

Graduate Advisory Committees of the graduate students assess student progress at the time of the proposal presentation, the thesis seminar, and the oral defense of the written thesis. This is currently an indirect measure of assessment. See below (and attached) for information concerning a new direct measure of assessment.

A student with an advanced degree in chemistry must have sufficient critical thinking and problem solving skills in order to succeed. **Graduate Advisory Committees** of the graduate students at the time of proposal presentations, literature seminar, thesis seminar, and oral defense of the written thesis will make evaluations of student progress. Progress and novel ideas for improvement are discussed within these committees, at faculty retreats and occasionally at faculty meetings. The results of the Chemistry M.S. Survey of Graduates and the Chemistry M.S. Survey of Faculty are also discussed at faculty meetings and retreats since they contain valuable information as a direct measure of assessment.

External program reviews (every 5 years) also contributes to improvements in the assessment tools utilized by the department. The results of these reviews are maintained in the Chemistry Chair's office.

Attached Files

Graduate Advisory Committee Thesis Assessment

Assessment: Seminar Program Evaluations Forms

Goal/ Outcome/ Objective: Outcome 1 & 2

Type of Tool: Focus Group

Frequency of Assessment: Annual

Rationale:

Both faculty and students attending student seminars fill out an evaluation form (Attached) on the student speaker. This is helpful to both the student giving the seminar as well as the student grading the seminar. These are kept by the Seminar Program Coordinator, who also provides feedback to students, and to the M.S. Program Coordinator.

Attached Files

Seminar Evaluation Form

Results: Delaware Study, Institutional Research Data and Annual Report

Goal/Objective/Outcome Number: Program Goals 2, 3 & 4

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 previous 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 Report).

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
2018-2019	$434,356	$223K
Total last 12 years	**$ 6,694,769**	**$2,341,000**

The average load of the research active faculty is now 9.2 contact hours, however, the average load when all permanent faculty are considered is 10.5.

Year	Number of Graduates
2007-2008	4
2008-2009	6
2009-2010	6
2010-2011	6
2011-2012	5
2012-2013	6
2013-2014	4
2014-2015	6
2015-2016	7
2016-2017	10
2017-2018	5
2018-2019	4

Attachments:

Results: Graduate Advisory Committee

Goal/Objective/Outcome Number: Outcomes 1 & 2

Results:

Until recently, the Graduate Advisory Committees performed an indirect measure of assessment, as only pass/fail was awarded where graduation from the program was concerned. In the last five years, all students have passed and graduated that term. Now, we also have a more direct measure of assessment. The results of that assessment are attached. These results will be compiled every 3 years.

Attachments: Attached Files

Graduate Advisory Committee Thesis Assessment Results

Results: M.S. Survey of Graduates

Goal/Objective/Outcome Number: Outcome 1 and 2

Results:

Numerical results on very small sample sizes corresponding to our number of graduates must be viewed with caution. Nonetheless, results of this survey compiled for the years (2000-2005) vs. (2006-2010) vs. (2010-2015) are provided in the attached file. Among the items relevant to Learning Outcome 1 (application of the scientific method), we noted that those with the lowest scores in the 2005 cohort were Items 14 (keeping organized lab records) and 15 (statistical analysis of data). The score on Item 14 improved in the 2010 compilation but remained basically the same in 2015. The coordinator of the Chemistry M.S. program, in consultation with the department chair and other graduate faculty in the department, prepared a handbook for the program useful for both students and faculty in the program. The manual outlines goals and expectations for the progress of every student toward this learning outcome. The handbook is available online at the following link: http://www.tntech.edu/chemistry/masters-handbook/. This manual plays an important role in advising, as assessed by the

Composite Score on Advising (Items 11,17-22,29), and is implemented to improve this aspect of our program. The graduates of the program score us highest in the areas of advising as evidenced by the Composite Score on Advising. The next compilation of results will be completed in Spring/Summer 2020 covering 2016-2020.

Attachments: Attached Files

MS Survey of Graduates Results

Results: MS Survey of Faculty

Goal/Objective/Outcome Number: Outcome 1 & 2

Results:

The Chemistry Faculty has turned over during the last 6 years and grown, as well. Since there are only a few tenured faculty remaining in the department, assessment by faculty is developing a new baseline, thus, comparison to previous surveys is not very accurate. The most recent survey of faculty completed in Spring 2016 is attached. The next survey of faculty will be available 2020.

Attachments: Attached Files

MS Survey of Faculty Results

Results: Seminar Program Evaluation

Goal/Objective/Outcome Number: Outcome 1 & 2

Results:

Refer to Assessments or the results of the Chemistry M.S. Survey of Graduates compiled for the years (2000-2005) vs. (2006-2010) vs. (2010-2015) and the Seminar Program Evaluation Form. Among the items relevant to Learning Outcome 2 – Effective Communication, the Composite Score on Learning Outcome 2 (Items 11, 16, 27) is most relevant. The average score decreased from 3.50 to 3.33 to 3.13 between the 2005, 2010 and 2015 reviews, respectively. This change is within statistical uncertainty in the small sample sizes being averaged here, (6 vs. 10 vs. 11 graduates, respectively), and thus should be viewed with caution. Several students have had to perform their seminar a second time in order to be compliant with the goals of the seminar program.

Attachments:

Results: Directory of Graduate Research & Scifinder Scholar

Goal/Objective/Outcome Number: Program Goal 1

Results:

As assessed by the Directory of Graduate Research (through 2013), the following table tabulates the **publication productivity** in the department of chemistry. We more than exceeded our target several years. Since there is inherent variability in such data, we have included in Table 1 the total publications for the period 2001-2014 compared to the target expected and we are near our target as of this writing. This goal will continually be assessed on a two-year cycle, although SciFinder Scholar will be used as the direct assessment tool. Two-Year cycle is defined, for example, as papers published during calendar year 2017 and 2018 and reported as 2017-2018.

Refereed Publications Listed in the Directory of Graduate Research (DGR)

Years Tabulated	# of Publications	Target (5% increase)
1991-2001	17 (average)	
2001-2002	21	18
2003-2004	21	19
2005-2006	30	20
2007-2008	17	21

2009-2010	11	22
2011-2012	13	23
2013-2014	20	24
2015-2016	41	25
2017-2018	41	27
2019-2020		
2001-2018	**232**	**175**

Attachments:

Modifications and Continuing Improvement: Outcome 1

Goal/Objective/Outcome Number: Outcome 1

Program Changes and Actions due to Results:

For Student Learning Outcome 1 the department has continued to use Graduate Advisory Committees of the graduate students to evaluate progress in proposal presentations, literature seminar, thesis seminar, and oral defense of the written thesis. We implemented an ongoing policy in 2007 as published in our M.S. Handbook requiring students to have available at all times their up-to-date laboratory notebooks for reference by thesis committees. We also began in the past 5 years to offer special topics courses in statistical data analysis on a regular basis, although the score on Item 15 did not show improvement. We will continue to monitor assessment data on all relevant items, including those in the assessment instrument, the Chemistry M.S. Faculty Survey. The lowest composite score in the 2005 review was in the Facilities area (See MS Faculty Survey Results). To address this issue the Chemistry Department has undertaken major renovation of both classroom and laboratory space for research, opening up all of Foster Hall fourth floor. This allowed new research lab space for four faculty, new office space for M.S. program advisement, a new Student Learning Commons, and a new Graduate Student Office Complex with tables for group work. This was completed in 2011. The 2015 review showed an improvement by both students and faculty. The coordinator of the Chemistry M.S. program, in consultation with the department chair and other graduate faculty in the department, prepared a handbook for the M.S. program useful for both students and faculty in the program. The manual outlines goals and expectations for the progress of every student toward this learning outcome. This handbook is annually updated. Faculty are required to address each of the action points in the Learning Outcome during their mentoring relationships with students. The handbook is available online. This manual plays an important role in advising, as assessed by the Composite Score on Advising (Items 11,17-22,29), and is implemented to improve this aspect of our program.

Link to Assessment:

Graduate Advisory Committee and Graduate Student Survey

Link to 'Tech Tomorrow' Strategic Plan: Adult Learners

Alumni/Friend Engagement

Modifications and Continuing Improvement: Outcome 2

Goal/Objective/Outcome Number: Outcome 2

Program Changes and Actions due to Results:

In order to make progress on Learning Outcome 2, assessment results relevant to communication skills have driven the department to change the way the seminar program is structured. First of all, the coordinator of the Chemistry M.S. seminar program, in consultation with other graduate faculty in the department, have assisted a department faculty member in preparing oral presentation guidelines for students giving seminars in the M.S. program. Secondly, the graduate student's first seminar, the Literature Seminar, has been moved to its own time slot separate from the outside speaker seminar day and time in order to provide a more informal setting with more give-and-take for students' gaining experience in giving presentations. These two changes have improved the performance of M.S. students in our seminar program, as perceived in our Literature and Thesis Seminars results. These are kept on file by the seminar coordinator. Student perception (2015) as evidenced by exit surveys, do not reflect this, even though we have noticed an improvement.

In order to provide Graduate Advisory Committees a direct measure of assessment, the department has created a rubric that can be used to assess graduating students called the Thesis/Research Defense Assessment (Graduate Advisory Committee Thesis Assessment). This is a new assessment tool implemented in 2014, and is thus immature at this time (only 6 students have been scored so far). When utilized, this tool will allow scoring in 7 areas related to Outcomes 1 and 2 (1 to 4 points awarded in each area) and thus allow direct assessment for each Learning Outcome.

Link to Assessment:
Graduate Advisory Committee Thesis Assessment with Rubric
Link to 'Tech Tomorrow' Strategic Plan: Adult Learners
Alumni/Friend Engagement

Modifications and Continuing Improvement: Outcome 2

Goal/Objective/Outcome Number: Outcome 2
Program Changes and Actions due to Results:
In order to make progress on Learning Outcome 2, assessment results relevant to communication skills have driven the department to change the way the seminar program is structured. First of all, the coordinator of the Chemistry M.S. seminar program, in consultation with other graduate faculty in the department, have assisted a department faculty member in preparing oral presentation guidelines for students giving seminars in the M.S. program. Secondly, the graduate student's first seminar, the Literature Seminar, has been moved to its own time slot separate from the outside speaker seminar day and time in order to provide a more informal setting with more give-and-take for students' gaining experience in giving presentations. These two changes have improved the performance of M.S. students in our seminar program, as perceived in our Literature and Thesis Seminars results. These are kept on file by the seminar coordinator. Student perception (2015) as evidenced by exit surveys, do not reflect this, even though we have noticed an improvement.

In order to provide Graduate Advisory Committees a direct measure of assessment, the department has created a rubric that can be used to assess graduating students called the Thesis/Research Defense Assessment (Graduate Advisory Committee Thesis Assessment). This assessment tool was implemented in 2014.

Link to Assessment:
Graduate Advisory Committee Thesis Assessment with Rubric
Link to 'Tech Tomorrow' Strategic Plan: Adult Learners
Alumni/Friend Engagement

Modifications and Continuing Improvement: Program Goal 1

Goal/Objective/Outcome Number: Program Goal 1
Program Changes and Actions due to Results:
In order to continue to make progress towards Program Goal 1, **we will continue** to use the Clayton Faculty Enrichment Fund in our department, instituted in 2003, **to stimulate faculty development by travel to scientific meetings** to foster greater opportunities in research **that culminate in refereed publications**. A differential teaching load was designed and implemented in 2006 which provided larger blocks of time available for research and scholarly writing. This differential teaching load continues. The hiring of 3 lecturers by the department has enabled the continuation of the differential teaching load.

Link to Assessment:
Faculty Involvement in Publications
Link to 'Tech Tomorrow' Strategic Plan: Alumni/Friend Engagement

Modifications and Continuing Improvement: Program Goal 2

Goal/Objective/Outcome Number: Program Goal 2
Program Changes and Actions due to Results:
As indicated in the Departments Annual report, **we have made significant progress towards Program Goal 2**. In order to continue to make even greater progress in Program Goal 2, **grant writing by the faculty has been strongly encouraged**. NSF-CCLI and NSF-MRI instructional/instrumentation grants have been **submitted** and **funded** in order to obtain needed laboratory equipment to be used in research and teaching laboratories, and **major instrumentation grants have been authored and funded**. Starting in 2006, **release time from teaching has been given to faculty receiving external funding**

for research. A **differential teaching load was implemented** to give faculty credit for grant writing, involvement of students in research, extensive service activities, and so forth. Several new faculty have recently been hired and each is required to vigorously pursue the acquisition of external funding.

Link to Assessment:

Annual Report

Link to 'Tech Tomorrow' Strategic Plan: Alumni/Friend Engagement

Modifications and Continuing Improvement: Program Goal 3

Goal/Objective/Outcome Number: Program Goal 3

Program Changes and Actions due to Results:

In order to continue to make **even greater progress in Program Goal 3** a faculty committee began working on establishing new departmental policies regarding teaching assignments. These reflect time spent in a more quantitative fashion on grant writing, support of student research, special service work, and so forth. The end result was a **differential teaching load based on level of activity** allowing greater time to oversee graduate students, author proposals and maintain funding. The department recently obtained three new permanent positions and four temporary full-time Instructors which have also aided our ability to maintain the current loads in spite of a large increase in the number of students taking chemistry classes since 2007. During 2014-2016, three of the temporary full-time instructors were converted to Lecturer's. This permanent assistance will help keep faculty loads where they need to be for enhanced research.

Link to Assessment:

Agreement on Responsibilities, Faculty Course loads

Link to 'Tech Tomorrow' Strategic Plan: Alumni/Friend Engagement

Modifications and Continuing Improvement: Program Goal 4

Goal/Objective/Outcome Number: Program Goal 4

Program Changes and Actions due to Results:

In order to **continue to make progress in Program Goal 4**, which is tracked by a combination of University data and the Department's Annual Report, **we will continue to provide the most fiscally responsible ways** to fund graduate students. The **fast-track M.S. program**, started in 2006, **boosted the productivity rate** by getting qualified students through the program in less than two years. Eight students have taken advantage of this program since 2006 and additional students are currently taking advantage of this program. We continue to encourage faculty to include **research assistantship stipends** in their external grants, and typically have at least two students supported in that manner. **Three more teaching assistantships (bringing our total to 15) have been added** to the program, and should plan a large role in future success. We have an **active request (2019)** at this time to add 3 additional teaching assistantships to this program.

Link to Assessment:

Enrollment data

Link to 'Tech Tomorrow' Strategic Plan: Adult Learners