1. Program Reporting
Select the College or Division: Klingler College of Arts and Sciences

Department/Program/Degree:
Chemistry Major

2. Name of the Program Assessment Leader Filing this Report
Daniel Sem

3a. Did the faculty/staff change any program learning outcomes since the last report (September 2008)
☒ No
☐ Yes

3b. If yes, list the current program learning outcomes
Actually, we simply reworded them for clarity; no substantive changes.

4. Are the program learning outcomes listed on the program’s web pages?
☐ No
☒ Yes

5. Do students in the program routinely receive copies of the learning outcomes?
☒ No
☐ Yes

6. Do program faculty/staff regularly receive copies of the learning outcomes?
☐ No
☒ Yes

7. Academic programs only: Provide the number of students graduating (receiving a degree) from this program in AY 2008-2009.
6

A. Please enter the text of the first program learning outcome (outcome 1).
Demonstrate clear understanding of concepts, with ability to solve problems in the major traditional areas of chemistry: Analytical, Inorganic, Organic & Physical.

Describe all of the measures you used to assess this first learning outcome.
Primary: Scores on the ACS (American Chemical Society) standardized national test: We currently use the ACS tests in Physical Chemistry and in Organic Chemistry. If a student scores in the 80-100 national percentile, they are characterized as "Excellent", in the 60-80 national percentile, as "Very Good", in the 50-60 percentile as "Good", and at <50 percentile as Poor (i.e. not meeting expectations). Note: in the case of the ACS Organic test, percentile is national percentile, but for ACS Physical Chemistry exam, the national data were not yet available, so numbers refer to % correct on the exam itself.
Secondary: When ACS test scores are not available, we rely on course grades in courses in each of the core areas – this is based on our previous demonstration of a correlation between ACS standardized scores and course grade.

Additional: Visualization of molecules in 3D, and drawing conclusions based on this, is an essential skill. To assess this learned skill, and determine if we are teaching for different learning styles, students are given: (a) a quiz to assess stereochemistry visualization (Stereochem-3D) and (b) the VARK assessment tool to determine learning style.

The stereochemistry-3D assessment consisted of 3 questions, where students were asked to compare a panel of molecules from different visual perspectives, and identify similar or different pairs - this required them to rotate the molecule in their head, to be able to obtain the correct answer (i.e. identify enatiomers, disateriomers). All 3 correct was scored Excellent, 2 out of 3 as Good, and 1/3 scored as Poor. (note: this assessment was given at the begining of the semester in Chem125; it was also given at the end of the semester with similar results (4 excellent, 2 good); the assessment was not on material being taught in the course where it was given).

The VARK was not to assess learning outcome (so scores are not given below), but rather to see if students with different learning preferences (Visual, Aural, Read-Write, Kinesthetic) were predisposed to do better or worse in chemistry. In fact, we found no correlation between VARK categorization of learning style, and how well the students performed on our learning outcomes.

Provide the total number of students assessed on each measure for outcome 1.

6

Data Table for Learning Outcome 1:

<table>
<thead>
<tr>
<th>Performance Indicators</th>
<th>Poor</th>
<th>Good</th>
<th>Very Good</th>
<th>Excellent</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACS Organic</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>ACS PChem</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Grade: Inorg-1</td>
<td></td>
<td></td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Grade: Inorg-2</td>
<td></td>
<td></td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>Grade: Anal-1</td>
<td></td>
<td>2</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Grade: Anal-2</td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Stereochem-3D</td>
<td>3</td>
<td></td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>&gt; Note: Only 5 were assessed.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grade: Bioch.</td>
<td></td>
<td>4</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

B. Please enter the text of the second program learning outcome (outcome 2).

Display proficiency in fundamental Chemistry laboratory skills.

Describe all of the measures you used to assess outcome 2.

Use of rubric for scoring key laboratory skills, assessed by evaluation of laboratory reports, for skills such as: (a) overall quality of report, (b) how students make use of significant figures, (c) yield for a reaction, based on data. Scoring is by the professor, using a rubric. Due to the quantitative nature of this analysis, we typically use labs in Analytical Chemistry for this assessment measure.
The assessment used was a small variation from what was in our original assessment plan. As implemented in the iron ore lab, in analytical chemistry, it is in three areas:

1) Performing accurate laboratory measurements:

Scoring:
- 4 or 5 out of 5 for iron ore accuracy, exceeds expectations
- 3 out of 5 for iron ore accuracy, meets expectations
- 2 or less out of 5, fails to meet expectations

2) Responsible handling of scientific data. Reporting of data in tables where appropriate, use of significant figures to indicate precision, and use of units

Scoring:
- Exceeds expectations: consistently used the correct number of significant figures and units
- Meets expectations: used the correct number of significant figures and units more than 75% of the time
- Fails to meet expectations: used the correct number of significant figures and units less than 75% of the time

3) Draw conclusions based on the data.

Scoring:
- Exceeds expectations: scored 8 or more out of 10 on professor graded discussion
- Meets expectations: scored 6-7 out of 10 on professor graded discussion
- Fails to meet expectations: scored 5 or less out of 10 on professor graded discussion

Provide the total number of students assessed on each measure for outcome 2.

6

Data Table for Learning Outcome 2:

<table>
<thead>
<tr>
<th>Performance Indicators</th>
<th>Fails to meet expectations</th>
<th>Meets expectations</th>
<th>Exceeds expectations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-Measurement</td>
<td>1</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>2-Data handling</td>
<td>1</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>3-Conclusions</td>
<td>1</td>
<td>4</td>
<td>1</td>
</tr>
</tbody>
</table>

C. Please enter the text of the third program learning outcome (outcome 3).

Responsible handling of scientific data, and proficiency in writing scientific reports, which includes overall quality of writing (clear; logical; scientifically sound), as well as proper / ethical citation of the scientific literature.

Describe all of the measures you used to assess outcome 3.

a) Students in CHEM125 (Biochemistry) write mock NIH grant proposals, which are scored using a modified NIH (National Institutes of Health) rubric by: (i) the course professor, and (ii) an external reviewer.
b) Oral presentations are scored in Physical and Analytical Chemistry, using a rubric that is a modified form of the University Libraries rubric.
c) Reports are submitted to turn-it-in.com (to assess proper citation of literature).

Details of the scoring of Oral presentations in Physical Chemistry:
CHEM 136 Ethics Case Study
Students were provided with a case study and were asked to write a one-page summary that identified:
• Issues and points of ethical conflict
• Points of view of all interested parties
• Consequences of acting
• Duties and obligations of protagonists

Prior to receiving the assignment, one lab lecture was devoted to a general discussion of air quality issues (the subject of the case) and students were provided with a detailed explanation of how to perform the analysis. A class discussion was held during the following week, after students had completed their initial summary, to discuss the above points with respect to the case and then students were asked to write a response indicated how the discussion influenced their evaluation of the case. The rubric used to score presentations is:

10 Initial summary contained all four points, student participated in discussion, response included discussion of others’ points of views.
9 Initial summary missed one point, student participated in discussion, response included discussion of others’ points of views
8 Initial summary missed two points or response did not indicate significant reflection on class discussion, student participated in discussion.
5-7 Major parts of the assignment were not addressed or student did not participate in discussion.
Below 5 Inadequate preparation, no class participation and/or missing or incomplete reflection.

10=Excellent; 9=Very good; 8=Good; <= 7 Poor

In the Analytic Chemistry class, Oral presentation of experiments were given by students and were graded by the TA. They were binned into the categories below based on scores (although, to fit in the table we say Excellent = exceeds expectations; Good = meets expectations; Poor = Fails to meet expectations).

<table>
<thead>
<tr>
<th>Performance Indicators</th>
<th>Poor</th>
<th>Good</th>
<th>Very Good</th>
<th>Excellent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grant: Internal</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Grant: External</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

The "Reports" performance indicator simply states that no incidence of plagiarism were identified using turnitin.com analysis.

Provide the total number of students assessed on each measure for outcome 3.

6

Data Table for Learning Outcome 3:
D. Please enter the text of the fourth program learning outcome (outcome 4).

This is not a learning outcome per-se; rather, we have listed how our six chemistry graduates performed on the VARK instrument (www.vark-learn.com/english/index.asp), in terms of learning style. In learning outcome #1, we established that there was no correlation between learning style and performance using different measures of learning outcome. Here we show that our majors cover the spectrum of learning styles; our intention is to not disadvantage or dissuade any particular learning style from successful pursuit of a chemistry degree.

Describe all of the measures you used to assess outcome 4. A high V score indicates students learn best visually (ex. Powerpoint; chalkboard), a high A score indicates preference for Aural learning (ex. lectures), a high R score indicates a Read/Write learning style (ex. text book) and a high K indicates a Kinesthetic style (ex. handling physical models of molecules).

Provide the total number of students assessed on each measure for outcome 4.

6

Data Table for Learning Outcome 4:

<table>
<thead>
<tr>
<th>Performance Indicators</th>
<th>V-style score</th>
<th>A-style score</th>
<th>R-style score</th>
<th>K-style score</th>
</tr>
</thead>
<tbody>
<tr>
<td>student 1</td>
<td>3</td>
<td>7</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>student 2</td>
<td>9</td>
<td>3</td>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>student 3</td>
<td>5</td>
<td>12</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>student 4</td>
<td>1</td>
<td>4</td>
<td>11</td>
<td>7</td>
</tr>
<tr>
<td>student 5</td>
<td>7</td>
<td>6</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>student 6</td>
<td>6</td>
<td>6</td>
<td>8</td>
<td>7</td>
</tr>
</tbody>
</table>

8b. If all of the program learning outcomes were not assessed in AY 2008-2009, is the program following a written assessment rotation plan?

□ No
□ Yes

8c. Please describe the status of any actions taken to improve learning during academic year 2008-2009 which were proposed by the program faculty and reported in the academic year 2007-2008 annual program assessment report.

We have implemented the use of the standardized ACS tests in two of the major divisions of chemistry (organic and physical chemistry), and we have instituted a new assessment for 3D visualization of molecules ("stereochem-3D") based on key quiz questions provided in students' senior year, and we have assessed scientific writing by scoring a mock NIH grant proposal. These were viewed as good additions to our assessment program, by the faculty. Also, faculty met to discuss, modify, and ultimately approve the assessment plan.
Use of the Assessment Data

9. Did department or program faculty/staff receive a report of these academic year 2008-2009 assessment results?
   ☒ Yes

   ☐ No

10a. Did department or program faculty/staff meet face to face to discuss and analyze the academic year 2008-2009 assessment results?
   ☒ Yes

   ☐ No

10b. Please describe the conclusions which program faculty/staff reached about student learning based on their analyses of the academic year 2008-2009 assessment results.

We rewrote the assessment plan so learning outcomes were more clearly described, and better linked to assessment measurements that we could make. We also resolved to perform the national ACS test in other areas, namely inorganic and analytical chemistry, as we recognize that grades are not an adequate assessment metric. But, we noted that we do not need to assess every year with the ACS test, as long as we can establish on a regular basis (at least every 4 years) that there is a strong correlation between course grade and the ACS test score. We have done this with our 6 majors in P-Chem (R² = 0.83) and Organic Chemistry (R² = 0.90), and for the large Organic Chemistry class of 165 students. In the latter case, we obtained a correlation coefficient between course grade and ACS score of 0.8. Faculty agreed to do similar analysis for analytical and inorganic chemistry, and to establish the correlation with grade every 4 years.

We decided that learning outcomes were being achieved, and that all our students met or exceeded expectations. Notably, all of our students scored above the national average on standardized ACS exams in Physical Chemistry, and 5/6 scored above the national average in Organic Chemistry. Scientific report writing was assessed as exceeding expectations for most of our majors, as scored by both internal and external reviewers of the mock NIH grant proposal. Importantly, we used the well-established "VARK" assessment instrument to establish that our teaching of chemistry skills does not favor any particular learning style.

11. Describe the actions to improve student learning that the program will undertake as a result of the assessment data. Be sure to include a time-table to implement the change and identify who is responsible to implement the action. If no actions were adopted provide the rationale for this decision in the first box.

Improvement Action #1
Students met or exceeded expectations in learning concepts in the core areas of chemistry - and this was assessed by using standardized tests provided by the American Chemical society. But, we need to implement this standardized test in the other two core chemistry areas (Inorganic and Analytical) to ensure we are achieving this learning outcome in these areas as well. Grades must at least peridically, be correlated with ACS standardized test scores, so that we have confidence in the use of grades as an assessment tool - for those semester when the ACS standardized test is not given. As a faculty, we decided to do this at least every 4 years, for each of the 4 areas in chemistry.

Improvement Action #2
Laboratory skills were assessed only for the analytical chemistry lab, as it is more amenable to quantification methods of assessment. In general, students met or exceeded expectations. But, we feel we need to work on developing a more detailed rubric for scoring these skills, and to
extent the assessment to one other chemistry area - perhaps one that also involves synthesis, so yield in a chemical reaction can be calculated.

Improvement Action #3
Written and oral communication skills of our students were generally good, but there was some variability. For example, internal scores of grant proposals were somewhat more generous than external scores, and there were some low scoring students (1-2 out of the 6). Variability might be addressed by developing a more detailed scoring rubric. Some additional class time will be spent on teaching scientific writing in the Chem125 class.

Statements for the One Page Program Assessment Report for Web External Audiences

12 a. Provide two to three sentences about the program’s most important assessment findings. Our majors (a cohort of only 6) met or exceeded expectations in all learning outcome areas, and based on the American Chemical Society standardized tests (ex. in Organic Chemistry), 5/6 of our students rank above the national average with 4/6 scoring in the 86th percentile and above. Also, we have established that our program does not favor or disfavor students with any particular learning style, as assessed using the VARK instrument.

12b. Provide two to three sentences about the actions the program will take this academic year to improve student learning. The lack of ACS standardized tests in 2 of the 4 major areas of chemistry leaves us with a poor assessment of our first learning outcome in those two areas, as we have only grades in core classes for those 2 areas. We will implement the ACS test in those areas - Inorganic and Analytical chemistry.