

**Academic Affairs Assessment of Student Learning**

**Report for Academic Year \_**2022\_-\_2023\_\_\_

**Department/Program \_\_\_Chemistry\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

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1. **Which learning outcomes did you measure this past year?** [Please indicate whether any of these measures were conducted as follow-up to a previous year’s issues or in response to Program Review. Be specific.]

Program Learning Outcomes, PLOs 1 and 3 was measured during the 2022-2023 academic year

• PLO 1. Explain the fundamentals in organic, analytical, physical, inorganic, chemistry. biological

• PLO 3. Apply problem-solving strategies to scientific

1. **In which course(s) were assessments conducted?**

|  |  |  |
| --- | --- | --- |
| PLOs Assessed | Assessment Point | Assessment tool (Direct or Indirect |
| 1 and 3 | Chemistry 206 Organic Chemistry II | ACS two semester Organic Chemistry Exam (Direct) |
| 1 and 3 | Chemistry 301 Physical Chemistry (Fall Semester) | ACS one semester Physical Chemistry Exam (Direct) |
| 1 and 3 | Chemistry 450 Senior Seminar (Spring Semester) | ACS DUCK\* Exam (Direct) |
| 1 – 6 | Chemistry 450 Senior Seminar | Department Graduate Exit Survey (Indirect)\*\* |

\*DUCK: Diagnostic of Undergraduate Chemistry Knowledge

\*\* This is an internally generated survey aligned with our program learning outcomes. It solicits information from the graduating seniors on how well they thought the department met its program learning outcomes.

1. **How did you assess the selected program learning outcomes?** (i.e., what did you assess –group project, skills demonstration, presentation, performance, debate, lab experiment, online discussion, etc. *and*- what tool (measure) did you use - rubric, nationally or state-normed exam, item analysis, pre-posttest design, skills inventory, survey, etc.)

The American Chemical Society is the world’s largest scientific professional society. It has a Committee on Education and a national test center that develops a test for numerous classes in the standard chemistry curriculum. The department decided to use this standardized test sequence due to its ability to place students in a national percentile so we can determine how our students stack up against other nationally. Each of the tests can be further broken down to give use data on where our students are struggling in the sub disciplines of general, organic, physical, and chemistry overall Diagnostic of Undergraduate Chemistry Knowledge (DUCK test).

1. **How many students were included in the assessment(s) of each PLO in a course?**

The number of students who took each examination is broken down in the following table. The Chemistry 106 and 206 had a significant percentage of Biology majors taking the test while the Chemistry 301 and 450 assessment tool was strictly chemistry majors.

|  |  |
| --- | --- |
| Assessment Evaluation | Number of students who completed the assessment tool |
| **Second term General Chemistry test – Chemistry 106** | **47** |
| **Second term Organic Chemistry test – Chemistry 206** | **16** |
| **First Term Physical Chemistry test – Chemistry 301** | **4** |
| **Senior Seminar – Chemistry 450 – DUCK Test** | **4** |
| **Graduate Assessment Survey** | **5** |

1. **How were students selected to participate in the assessment of each outcome (**Helpful details might include- whether this assessment represents all students, a sample of students in a class, or a sample of students across sections)?

Every student who completed the courses in question were given a copy of the exam as part of their course work. All graduates for the corresponding survey were sent a copy of the graduate survey and asked to complete the survey. With reminders the surveys were completed and submitted to the College Administrative Assistant until after graduation to protect the anonymity of the graduate submitting the survey. Physical Chemistry, Senior Seminar, and the DUCK test were only given to Chemistry majors. The Organic Chemistry and General chemistry test recipients were mostly students taking the classes as cognates. These majors include biology, engineering, criminal justice, or pre-professional health science majors.

1. **In general, describe how each assessment tool (measure) was constructed** (i.e. in-house, national, adapted).

The course assessment examinations were written by faculty from across the country in their professional service the American Chemical Society’s Division of Chemical Education Examination. These are nationally standardized exams that show the expectations of professional and graduate schools from across the nation. The graduate survey was written by faculty within the Department.

1. **Who analyzed results and how were they analyzed**

The professor who taught the course is the faculty member who was responsible to do the assessment for the examination. The Assessment Coordinator then compiles the assessment for the Department Reports. The Course examinations were broken down into the content areas to determine where students achieved the poorest scores.

|  |  |
| --- | --- |
| Assessment examination | Faculty responsible for assessment |
| Chemistry 106 General Chemistry II | Micheal Fultz |
| Chemistry 206 Organic Chemistry II | Micheal Fultz |
| Chemistry 301 Physical Chemistry | Mahinda Ranasinghe |
| Chemistry 450 Senior Seminar | Micheal Fultz |
| Graduation Survey | Micheal Fultz |

1. **Provide a summary of the results/conclusions from the assessment of each measured Program Learning Outcome.** *Report scores for this assessment, as well as students’ strengths and weaknesses relative to this learning outcome.*

Based on the individual tests given during the 2022-2023 academic year the following items were noted

* ACS two semester General Chemistry Exam: The results of this test demonstrate that students struggle to apply the correct formulas to solve the required problem. The department covers the formulas and the basic concepts due to many students coming from backgrounds with very little chemistry instruction. This limits the amount of time faculty can demonstrate those formulas in higher more complex cases. In particular students struggle with kinetic and thermodynamics of a chemical reaction. One of the faculty teaching general chemistry fall 2023 will be attending the National American Chemical Society meeting in spring 2024 to look over the how other institutions are developing their curriculum in general chemistry.
* ACStwo semester Organic Chemistry Exam: The results of the 2022-2023 academic year who took this exam during the academic year has been item analyzed by topic. Each question was classified into one of five topic/concept areas – general organic, chirality, mechanisms, synthesis, and spectroscopy. Based on the item analysis data, students, areas of greatest weakness were spectroscopy followed by, synthesis, general organic, and mechanisms. The greatest proficiency was in determining the chirality of molecules. This is consistent with previous years as this is typically a strength. Every year we continue to try incorporate more practice in spectroscopy. **For the 2023 – 2024 academic year a textbook change that incorporates spectroscopy earlier into the curriculum so practice can start earlier in the semester with both the labs and the lecture component or Organic II. Practice is the only way to improve the technical abilities of evaluating spectra for structure determination.**
* ACS 1st semester Physical Chemistry Exam: As a measure of the students’ knowledge assessment, the standard test developed by American Chemical Society (Form 2021) was utilized. This exam consists of 50 multiple-choice questions. This test covers major topics in the areas of Gases, Thermodynamics, Chemical Equilibrium, Phase Equilibrium, an introduction to Statistical Thermodynamic. Students taking this course are expected to have a thorough knowledge of Mathematics at least up to Calculus III level. The topics covered in this course use various mathematical concepts and the deficiency in mathematic knowledge can be challenging for both the students and the instructor. Also, in order to fully understand the concepts, students are encouraged to solve selected end of the chapter problems. Students can work as a group when solving these problems but must submit a separate assignment in the online course module.

**Table 1.** Students correct responses breakdown

|  |  |  |
| --- | --- | --- |
| **Students’ response** | **Questions** | **Percentage** |
| All student correct | 2 | 4% |
| Three of the student correct | 8 | 16% |
| Two of the students correct | 8 | 16% |
| One of the students correct | 20 | 40% |
| All students wrong | 12 | 24% |

According to the table 1, all students got 24% of the questions wrong. Some of these questions tested the same concepts. It is puzzling to me that students got some of them correct but the others incorrect. This trend suggests that a deep understanding on applications of concepts learned during the lecture was weaker. For example, Questions that covered the concepts related to first law of thermodynamics yet students could not identify that concept in the questions. Another example is questions related to the concepts of chemical potentialyet students struggled to identify them

Several factors can contribute to deficiency in understanding the thermochemical concepts covered in the course. One of the major reason is the lack of doing practice problems that cover the concepts in different ways. **In order to give students more opportunities to solve problems, there will be more optional recitation session outside of the regular lecture time.**

* ACS Diagnostic of Undergraduate Chemistry Knowledge (DUCK) Exam: This exam is given to all students in Senior Seminar at the end of the Spring 2023 semester.  Student scores in chemistry sub-disciplines increased (lowest to highest) in the following respective order; Inorganic, Biological, Physical, Analytical, and Organic.

* Department Graduate Exit Survey: The graduation survey, aligned to the Department’s PLOs, solicits graduating students’ opinions on how well the department is achieving its PLOs. They were asked to respond as Extremely Well, Very Well, Adequately Well, Not Very Well, or Not at all. PLO 1, then worded as “Explain the fundamentals in organic, analytical, physical, inorganic, and biological chemistry” was subdivided into the five sub-disciplines of chemistry listed.

The department collected the survey that was completed by the single graduate. These surveys were unsealed at the end of the Spring 2022 period. The Numbers indicate the number of students who responded that way.

Program Learning Outcome 1- 6 – Indirect measured

1. Demonstrate a conceptual understanding and integration of the fundamentals in organic, analytical, physical, inorganic, and biological chemistry.

Organic Chemistry

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Extremely Well | Very Well | Adequately Well | Not Very Well | Not at all |
| 4 | 1 |  |  |  |

Comments:

* + - * 1. This class was intense.
        2. The professor is challenging but covers the material.

Analytical Chemistry

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Extremely Well | Very Well | Adequately Well | Not Very Well | Not at all |
| 2 | 2 | 1 |  |  |

Comments:

1. This class was significantly COVID impacted. It was very difficult to learn much here.

Physical Chemistry

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Extremely Well | Very Well | Adequately Well | Not Very Well | Not at all |
| 2 | 3 |  |  |  |

Comments:

1. This class is now set up different than the previous professor. More labs and that is good.
2. The Chem 202 course has been altered to be more help for those taking P chem. That helped in P chem.
3. Dr. Ranasinghe is very professional and uses a lot of Math in this course but is willing to help with that.

Inorganic Chemistry

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Extremely Well | Very Well | Adequately Well | Not Very Well | Not at all |
|  | 3 | 2 |  |  |

Comments:

Biological Chemistry

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Extremely Well | Very Well | Adequately Well | Not Very Well | Not at all |
|  |  | 1 |  |  |

Comments:

* + - 1. Perform practical, standard laboratory procedures and techniques with a high level of precision and safety.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Extremely Well | Very Well | Adequately Well | Not Very Well | Not at all |
| 3 | 1 | 1 |  |  |

* + - * 1. The labs are the best part of the program.
        2. More internship opportunities would be nice.
      1. Apply critical thinking and fundamental problem-solving strategies to scientific problems ranging from hands-on laboratory research to theoretical concepts.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Extremely Well | Very Well | Adequately Well | Not Very Well | Not at all |
|  | 3 | 2 |  |  |

* + - 1. Demonstrate effective use of chemical literature through identifying various information sources in conjunction with the retrieval and critical analysis of scientific literature.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Extremely Well | Very Well | Adequately Well | Not Very Well | Not at all |
|  | 2 | 2 | 1 |  |

* + - 1. Demonstrate effective oral, written, and computer-aided communication skills pertaining to chemical applications.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Extremely Well | Very Well | Adequately Well | Not Very Well | Not at all |
|  | 2 | 3 |  |  |

* + - * 1. Making the posters for URDC was helpful
      1. Conduct independent systematic research.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Extremely Well | Very Well | Adequately Well | Not Very Well | Not at all |
| 1 | 3 | 1 |  |  |

1. The SURE program has been very helpful here
2. Not really a part of the curriculum seen more in the extra research help complete this section.
3. **What are next steps?** (e.g., will you measure this same learning outcome again? Will you change some feature of the classroom experience and measure its impact? Will you try a new tool? Are you satisfied?)

While it is the job of every faculty member is to improve the comprehension of their students in the classes they teach. This does not stop, there is always room for improvement. To help with that there are several areas where the department is working to improve.

**General Chemistry (Chem 106) –** At this point one of the faculty members is attending a national American Chemical Society meeting in Spring 2024 to look at other regional campus on how they communicate the science. Additionally, we have a faculty member working on a proposal for a “Fundamental Chemistry Course” which would be equivalent to an enhanced general chemistry course designed for students who do not have a strong background in chemistry to help them succeed.

**Organic Chemistry (Chem 206) –** A grant is currently pending to try to purchase a new react microwave to incorporate modern curriculum in Diels-Alder and Fisher Esterification reactions in the lab. Should this grant be approved we will be updating the lab work to modern standards that will add more experience in both carbonyl chemistry as well as spectroscopy. The grant will be announced soon to determine if that route is successful. If not, other funding will be found.

**Physical Chemistry (Chem 301) –** The faculty teaching in this area will offer more optional recitation periods for additional practice time.

**DUCK test –** Student scores in chemistry sub-disciplines increased (lowest to highest) in the following respective order; Inorganic, Biological, Physical, Analytical, and Organic.  The department is looking at whether additional experiential learning opportunities (primarily internships) will be possible in inorganic or biochemistry lab work.

**Graduate Survey –** Based on the graduate surveys and challenges more experiential learning opportunities will be sought in both lab work (which will help in spectroscopy) and communication skills. This will be seen in Research Rookies, SURE, internships, and Chem 462. Communication skills will be through Undergraduate Research Day, Research Rookies, Summer Research presentations, and a more focused requirement in the classroom for papers using the chemical literature.

1. **Please attach an example of the assessment tool used to measure your PLO(s).** These can be added as an appendix, a link to the assessment, or sent separately in email with your report.

While we are not able to share a copy of the assessment evaluations from the American Chemical Society due to the test security guarantees signed by the Department Chair. A copy of the graduate survey is attached.

DEPARTMENT OF CHEMISTRY AND PHYSICS

GRADUATE EXIT SURVEY

PROGRAM LEARNING OUTCOMES

**Directions** – The survey will not be examined until after graduation has commenced, your results will remain anonymous throughout the study as well. Read the Department of Chemistry Program Learning Outcomes below. Answer the questions on how you, the pending graduate of the Department of Chemistry, perceive how successful the department was in providing an education in the following fields. Feel free to make comments on our strengths and weaknesses in each of the areas.

Take a moment individualize your education in each of the areas. Check the box that corresponds to your judgment of education provided to you in each area. Feel free to make comments about the strengths and weaknesses in each area of your education.

Choice definitions based on Likert scales for quantitative data analysis of qualitative data.

**Extremely Well** = “5 of 5” or “Greatly above my expectations” or “Well above average”

**Very Well** = “4 of 5” or “Above my expectations” or “Above average”

**Adequately Well** = “3 of 5” or “Met my expectations” or “Average”

**Not Very Well** = “2 of 5” or “Somewhat below my expectation” or “Below average”

**Not at All** = “1 of 5” or “Far below my expectations” or “Far below average/did not meet expectations at all”

Program Learning Outcome

1. Demonstrate a conceptual understanding and integration of the fundamentals in organic, analytical, physical, inorganic, and biological chemistry.

Take a moment individualize your education in each of the areas. Check the box that corresponds to your judgment of education in each area. Feel free to make comments about the strengths and weaknesses in each area of your education.

Analytical Chemistry

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Extremely Well | Very Well | Adequately Well | Not Very Well | Not at All |
|  |  |  |  |  |

Comments:

Biological Chemistry

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Extremely Well | Very Well | Adequately Well | Not Very Well | Not at All |
|  |  |  |  |  |

Comments:

Inorganic Chemistry

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Extremely Well | Very Well | Adequately Well | Not Very Well | Not at All |
|  |  |  |  |  |

Comments:

Organic Chemistry

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Extremely Well | Very Well | Adequately Well | Not Very Well | Not at All |
|  |  |  |  |  |

Comments:

Physical Chemistry

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Extremely Well | Very Well | Adequately Well | Not Very Well | Not at All |
|  |  |  |  |  |

Comments:

2. Perform practical, standard laboratory procedures and techniques with a high level of precision and safety.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Extremely Well | Very Well | Adequately Well | Not Very Well | Not at All |
|  |  |  |  |  |

3. Apply critical thinking and fundamental problem-solving strategies to scientific problems ranging from hands-on laboratory research to theoretical concepts.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Extremely Well | Very Well | Adequately Well | Not Very Well | Not at All |
|  |  |  |  |  |

4. Demonstrate effective use of chemical literature through identifying various information sources in conjuncture with the retrieval and critical analysis of scientific literature.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Extremely Well | Very Well | Adequately Well | Not Very Well | Not at All |
|  |  |  |  |  |

5. Demonstrate effective oral, written, and computer-aided communication skills pertaining to chemical applications.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Extremely Well | Very Well | Adequately Well | Not Very Well | Not at All |
|  |  |  |  |  |

6. Conduct independent, systematic research.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Extremely Well | Very Well | Adequately Well | Not Very Well | Not at All |
|  |  |  |  |  |

Any additional comments you would like to share about the strengths and weaknesses of the department.