

**Academic Affairs Assessment of Student Learning**

**Report for Academic Year \_**2021\_-\_2022\_\_\_

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

**Assessment Coordinator’s Name: Micheal Fultz**

**Assessment Coordinator’s Email Address: mfultz@wvstateu.edu**

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 will be measured during the 2021-2022 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** | **25** |
| **Second term Organic Chemistry test – Chemistry 206** | **29** |
| **First Term Physical Chemistry test – Chemistry 301** | **3** |
| **Senior Seminar – Chemistry 450 – DUCK Test** | **6** |
| **Graduate Assessment Survey** | **1** |

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.

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 2021-2022 academic year the following items were noted

* ACS two semester General Chemistry Exam: The results of this test demonstrate that students struggle in two areas, the math and applying the basic concepts to solve high level problems. The department focuses on teaching the formulas and the basic concepts due to many students coming from backgrounds with very little chemistry instruction. In particular students struggle with kinetic and thermodynamics of a chemical reaction. Currently the department is looking at some new labs to incorporate Green Chemistry concepts and kinetic and thermodynamic control of reactions. Studies show students learn best through experiential learning processes.
* ACS two semester Organic Chemistry Exam: The results of the fall semester section of students 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 chirality. This is consistent with previous years and we continue to try incorporate more practice in spectroscopy.
* ACS 1st semester Physical Chemistry Exam: An item analysis of student test scores by topic or concept showed student difficulty in; Properties of gasses, the First and Second Law of Thermodynamics. Several factors can contribute to deficiency in understanding the thermochemical concepts covered in the course. One of the major reason is the lack of proper math background. To assist with this the Chemistry 202 Courses which is a prerequisite for this class was redesigned to teach the relevant match concepts needed.
* ACS Diagnostic of Undergraduate Chemistry Knowledge (DUCK) Exam: This exam is given to all students in Senior Seminar at the end of the Spring 2022 semester.  Student scores in chemistry sub-disciplines increased (lowest to highest) in the following respective order; Inorganic, Physical, Biological, Analytical, and Organic.  The six students who took the test scored om the 90, 82, 78, 72, 72 and 47th percentile nationally. This means all of our students scored at or above the national norms for a student graduating with a Bachelor Degree in Chemistry.

* 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 |
| 1 |  |  |  |  |

Comments:

* + - * 1. This class was one of the most challenging the program had to offer. Fun class though.

Analytical Chemistry

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

Comments:

Inorganic Chemistry

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

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 |
| 1 |  |  |  |  |

* + - 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 |
|  | 1 |  |  |  |

* + - 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 |
|  | 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 |
|  | 1 |  |  |  |

* + - 1. Conduct independent systematic research.

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

1. **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) –** With the recent hiring of two new faculty members and a new lab manager we are working to improve the experiential learning of general chemistry II. We are currently looking to update and improve some of the General Chemistry Labs to cover both traditional concepts and current focuses. In addition, we are looking at the best time periods to offer the classes to best meet the needs of the students. One faculty member is looking into textbook publisher developed online content and virtual homework assignments to allow instant grading for students.

**Organic Chemistry (Chem 206) –** Carbonyl chemistry and spectroscopy were the lowest scoring areas in the 2021-2022 assessment cycle. There is a challenge in improving carbonyl chemistry since it is traditionally one of the last things in text books and covered in organic II. This is a challenge nationwide. Spectscopy is one of the first topics taught in organic II. Students need more practice in this area. It is being incorporated into all the exams throughout the semester as well as the lab reports due after the content is covered. An additional paper on spectroscopy will be added during the Spring 2023 semester to force the students to become better acquainted with at least one instrument covered in the course.

**Physical Chemistry (Chem 301) –** Several factors can contribute to deficiency in understanding the thermochemical concepts covered in the course. One of the major reason is the lack of proper math background. To assist with this the Chemistry 202 Courses which is a prerequisite for this class was redesigned to teach the relevant math concepts needed. In addition, a completely rebuilt laboratory component is being developed to give a better experiential learning program as well.

**DUCK test –** Student scores in chemistry sub-disciplines increased (lowest to highest) in the following respective order; Inorganic, Physical, Biological, Analytical, and Organic.  The department is looking at whether or not we need to incorporate inorganic chemistry earlier in the curriculum.

**Graduate Survey –** Based on the graduate surveys and challenges in analytical and research activities we have hired two new faculty members. One in Biochemistry to bring the chemistry expertise to the course. The second faculty member has a physical chemistry and analytical chemistry background. They will be teaching the disciplines that were the lowest scoring areas on the DUCK test or graduate surveys.

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, perceive how we did in the following fields. Feel free to make comments on our strengths and weaknesses in each of the areas.

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.