Academic Program:	Chemistry	**Date:**	July 27, 2022
Author(s):	Stephen F. Wolf and Jennifer K. Inlow		
Verify that each of the following documents is correct and current on the ISU Assessment Results Webpage by marking with an "X." Please submit any updated documents and/or corrections as soon as possible to Kelley Woods-Johnson, Assessment & Accreditation Coordinator at kelley.woods-johnson@indstate.edu.		_x__ Learning Outcomes _x_ Curriculum Map _x__ Assessment Plan	
Is this program offered on-campus AND distance? If "Yes," reported data should include students of both, disaggregated.		___ Yes _x_ No ___ Hybrid	

Student Learning Outcomes Assessment Expand table cells as necessary to accommodate requested information.

Learning Outcome(s) Assessed Include actual outcome language; enter one per line, add lines as needed	**Assessment Strategies Used**			**Established Benchmark for Proficiency**	**Actual Student Performance Relative to Benchmark**	**Prior Results for Comparison** (if applicable)
	Course	**Assignment/Activity**	**Evaluation Tool** i.e. rubric, exam key, preceptor evaluation, etc.			
1. Outcome #3 - Students pursuing a baccalaureate degree in chemistry will carry out basic **laboratory procedures** demonstrating appropriate use of instrumentation, quantitative measurement, and data analysis.	1. Data for these assessments are derived from multiple sections, courses, and instructors. Courses that had input in this assessment cycle were CHEM 340, 355, and 321L. Data was collected over two academic years: 2020-21 and 2021-22 (because we assess Outcome #3 every other year.)	1. Assessment of student basic laboratory procedures occur in multiple courses throughout the chemistry curriculum. These courses span a wide range of subdisciplines in chemistry including analytical, inorganic, and organic. These courses provide students with experience(s) in a wide array of procedures, techniques, and instrumentation. The 6 categories of lab skills we assess are listed in the Appendix of this report.	1. Students are evaluated as possessing skills that are not acceptable (NA=0), fair (F=1), good (G=2), or very good (VG=3) by the faculty performing the assessment. For each outcome we calculate a mean, weighted by the number of students assessed for each of the categories, and a weighed mean calculated across all categories. These scores allow us to conclude whether the overall average results are satisfactory or unsatisfactory. It also allows us to examine long-term trends. All supporting data is listed in the Appendix of this report.	1. An overall score ≥1.5 is deemed to be satisfactory. Our expectations are that the weighted mean of all categories in a given outcome are satisfactory or better.	1. Data for the six categories of Outcome #3, the weighted mean for each category, and a total score are given in the Appendix of this report. In all cases (every category and weighted mean) our students' mean score was ≥ 1.8 with a weighted overall score of 2.0. These results meet our current proficiency benchmarks which we deem satisfactory	1. Overall Score Results for Outcome #3 for both Assessment Cycle 2019-20 and Assessment Cycle 2021-22 are given in the Appendix. The weighed grand mean for all 6 categories for the current cycle is 2.0, slightly lower than the weighed grand mean for the 2019-20 cycle (2.3). While, there appears to be a downward trend for the 2021-22 cycle compared to the previous cycle in which this outcome was assessed (2019-20), its significance is not certain. Multiple factors, such as different courses used for assessment and different faculty performing the assessment, add variability and uncertainty to any interpretation.

2. Outcome #4 - Students pursuing a baccalaureate degree in chemistry will be able to demonstrate professional **communication skills**. (Oral and written)	2. Courses that had input in this assessment cycle were CHEM 405, 300, 340, and 341. Data was collected over two academic years: 2020-21 and 2021-22 (because we assess Outcome #4 every other year.)	2. Assessment of oral and written skills are performed primarily in CHEM 405 (Senior Capstone). Oral communication Skills were assessed based on each student presenting 2-3 short scientific PowerPoint presentations. Assessment of written communications skills were based primarily on 2-3 written abstracts that accompanied their presentations	2. Students are evaluated as possessing skills that are not acceptable (NA=0), fair (F=1), good (G=2), or very good (VG=3) by the faculty performing the assessment. For each outcome we calculate a mean, weighted by the number of students assessed for each of the categories, and a weighed mean calculated across all categories. These scores allow us to conclude whether the overall average results are satisfactory or unsatisfactory. It also allows us to examine long-term trends. All supporting data is listed in the Appendix of this report.	2. An overall score ≥1.5 is deemed to be satisfactory. Our expectations are that the weighted mean of all categories in a given outcome are satisfactory or better.	2. Data for the two categories of Outcome #4, the weighted mean for each category, and a total score are given in the Appendix of this report. In all cases (every category and weighted mean) our students' mean score was ≥ 1.7 with a weighted overall score of 1.8.	2. Overall Score Results for Outcome #4 for both Assessment Cycle 2019-20 and Assessment Cycle 2021-22 are given in the Appendix. The weighed grand mean for both categories for this cycle is 1.8, slightly lower than the weighed grand mean for the 2019-20 cycle (2.0). While, there appears to be a downward trend for the 2021-22 cycle compared to the previous cycle in which this outcome was assessed (2019-20), its significance is not certain. Multiple factors, such as different courses used for assessment and different faculty performing the assessment, add variability and can bias assessment results.

Student Success Activities

Use the "Academic Chair" tab in Blue Reports to view your program's data related to retention, persistence, time to/rates of graduation, etc., as applicable (undergraduate v. graduate). Share reflections and activities of program faculty in the table below. Consider curricular, pedagogical, advising, co-curricular, and student support efforts.

Describe current student success activities that are working well.	We provide free walk-in tutoring for freshman-level and sophomore-level chemistry and physics at the Science Help Center, and we have SI sessions (Supplemental Instruction) for these courses as well. These resources help ensure the success of Chemistry Majors through their freshmen and sophomore science course sequences. We provide opportunities for Chemistry Majors to participate in hands-on research under the direct mentorship of a faculty member during the summer through the Summer Undergraduate Research Experiences (SURE) program, and during the regular semesters for credit (CHEM 399 or 499). Hands-on research is a high-impact experience for students and is one of the most influential factors in determining retention and persistence of students through the four years of their Chemistry Major.

	We encourage Chemistry majors and minors to participate in the American Chemical Society (ACS) Student Affiliate (essentially our "chemistry club"). Participation in this group fosters a sense of community among Chemistry Majors and gives the students opportunities to interact with the faculty in an informal, small-group setting. They get career and graduate school advice from faculty in such a setting and learn more about the profession of chemistry. We employ Chemistry Majors as tutors in the Science Help Center and as lab assistants and teaching assistants for General and Organic Chemistry lab courses. When students have to teach other students as a tutor or in a lab, they learn the material better themselves—this helps solidify their knowledge of fundamental concepts and makes it more likely that they will perform well in their upper-level chemistry courses. The habits and skills they develop in these settings are also directly relevant to career readiness, for example, communication skills, working with others, content knowledge, and exercising flexibility and adaptability.
Based on Blue Reports data and review of current activities, what are the primary areas to focus on improving next year?	There are no concerning trends in our Blue Reports data. The total number of Chemistry Majors has decreased, but it is in proportion to the overall decrease in enrollment at ISU. We will focus on promoting the student success activities listed above. There may be opportunities to expand the SURE program under the umbrella of the ISU Advantage program. During the past two years we noted a trend of fewer students utilizing the Science Help Center. We will explore ways to promote or advertise the Help Center more widely, or to offer expanded hours.

If you don't have a Blue Reports account, you can request one using the webpage link, or your Department Chair, Associate Dean, or College Assessment Director can assist you.

Continuous Quality Improvement

Describe primary insights gained from analysis of findings. *What was learned? What questions did it raise? How does current performance compare to past (if applicable), and how might any prior action plans have influenced performance?*	In the table above (right-hand column), current performance in terms of weighted grand mean for Outcomes #3 and #4 is directly compared to past assessment of these two outcomes. While there appears to be a downward trend in the results for Outcomes #3 and #4 in this 2021-22 assessment cycle compared to the 2019-20 cycle when these outcomes were most recently assessed, the significance of these results is not certain. Multiple factors introduce variability into the data, such as different courses assessed in the two cycles and different faculty performing the assessment. It will be necessary to examine the results of the next assessment cycle in order to see if a downward trend continues. One question raised is whether the decrease in the overall score for Outcome #3 (laboratory skills) from 2.3 to 2.0 may be at least partially attributed to the pandemic. Due to a variety of constraints that were necessary in the freshman- and sophomore-level lab courses during Spring 2020 and Fall 2020 (and to some extent Spring 2021), freshmen and sophomores did not spend the "normal" number of hours in the lab engaged in hands-on work and did not complete as many experiments as they would have in a "normal" semester. This may have adversely affected their laboratory skill development, which may have become manifest in our

	current dataset—as these same students underwent assessment when they were enrolled in higher-level lab courses during Spring 2021, Fall 2021, and Spring 2022.
What findings-based actions are planned to maintain strong performance and/or improve student learning and success?	We described above our concern that the pandemic may have adversely affected students' lab skill development by decreasing the number of hours they spent engaged in lab experiments, as well as probably limiting the amount of close hands-on help they received from lab instructors due to the necessity of social distancing. Given this possibility, we will maintain our strong commitment to providing laboratory experiences in face-to-face, hands-on format for all majors-level chemistry lab courses. This is highly important for training Chemistry Majors in techniques used in the discipline, as well as for reinforcing concepts covered in the lecture courses and helping students to engage with the course material and the instructor. Our assessment of Outcome #4 (communication skills) is based primarily on data from CHEM 405, our senior capstone course that is required for all Chemistry Majors in their senior year. This course was recently approved as a new High Impact Practices (HIP) course for the Foundational Studies Program. Going forward, the course in its new "HIP format" will include more writing assignments than in the past. We hope this will have a positive impact on students' written communication skills that will be apparent in future assessment cycles.
What learning outcomes will your assessment plan focus on next year, and what changes, if any, are planned to improve assessment strategies and yield stronger data?	Our assessment process measures four outcomes, with two measured on alternating years. Next year, assessment of Outcomes #1 (fundamental concepts) and #2 (problem-solving skills) will be reported. We have already been collecting data on these two outcomes over the past academic year in order to have a more extensive data set next year. We would like greater faculty participation in data collection so that we can achieve a larger dataset spanning more courses. We believe this will lead to stronger data as it will help to average out biases of individual faculty members as well as provide an evaluation of student skills in a broader range of contexts/courses. We hope to achieve this by providing faculty better guidance about the information being sought, along with more timely reminders and hard deadlines for collecting the data each semester.
Describe faculty involvement in this assessment, and how will findings be shared with faculty/stakeholders (as applicable)?	Our practice in the last few assessment cycles has been to ask most of the faculty who teach the junior- and senior-level chemistry courses (and certain sophomore-level courses) to participate in data collection each semester, and most have complied. Unfortunately, participation in data collection for this current cycle was lower compared to previous cycles. We hope to improve faculty involvement as explained above. Information contained in this assessment report will be discussed at a departmental faculty meeting in Fall 2022. Feedback from the Office of Assessment will also be addressed at future Departmental Assessment Committee meetings as well as departmental meetings of the full faculty. This report and appendices will be posted on our departmental Canvas site so all chemistry faculty can review it at any time.

Student Learning Outcomes Assessment—Chemistry
2021-2022 Assessment Cycle

Tables A1 and A2 summarize **"Overall Scores"** for each category and outcome. The calculation of this score is analogous to the calculation of a GPA except the scale is 0-3 with not acceptable (NA=0), fair (F=1), good (G=2), and very good (VG=3). This score allows us to conclude whether the overall average results are satisfactory or unsatisfactory which should allow us to examine long-term trends. We consider scores <1.5 to be unsatisfactory and scores ≥1.5 to be satisfactory.

Additional raw data used for calculation of overall scores are given in Tables 3-11. These results are given as %-relative frequencies for each course. As most categories contain assessments from multiple faculty, courses, and sections, results are compiled and weighed by the number of students assessed to calculate a weighed mean. For outcomes containing multiple categories, grand weighed means are calculated to provide an overall assessment of students in that category.

Table A1. Comparison of overall scores for assessments of six categories of laboratory skills for the 2019-20 and 2021-22 assessment cycles.

Summary	Overall Score

	2019-20 Cycle	**2021-22 Cycle**
(1) Students are able to synthesize moderately complex compounds using contemporary techniques.	2.5	**2.1**
(2) Students are able to perform standard chemical compound purity procedures.	2.5	**2.1**
(3) Students are able to operate standard modern chemical instruments and interpret the results.	2.2	**2.0**
(4) Students are able to accurately carry out classical and instrumental quantitative methods of chemical analysis.	2.2	**1.8**
(5) Students are able to assess both accuracy and precision of analytical results.	2.1	**1.9**
(6) Students are able to use commercially available software for scientific calculations and data analysis.	2.4	**1.9**
Weighed grand mean	2.3	**2.0**

Table A2. Comparison of overall scores for assessments of written and oral communication skills for the 2019-20 and 2021-22 assessment cycles.

Summary	Overall Score

	2019-20 Cycle	**2021-22 Cycle**
(1) Oral communication	2.0	**1.9**
(2) Written communication	2.0	**1.7**
Weighed grand mean	2.0	**1.8**

Outcome #3--Students pursuing a baccalaureate degree in chemistry will carry out basic laboratory procedures demonstrating appropriate use of instrumentation, quantitative measurement, and data analysis. Students were evaluated to have laboratory skills that were not acceptable (NA), fair (F), good (G), or very good (VG).

Table A3. Results of assessment for three classes and weighted mean result. The weighted mean was calculated based on the number of students in each class.

Category 1	Result				Explanation
	NA	F	G	VG	
Students are able to synthesize moderately complex compounds using contemporary techniques.	0.0%	0.0%	0.0%	100.0%	CHEM 340; Fall 2021; 5 chemistry majors; Student assessment is based on an experiment of “Diironenneacarbonyl”. Students need to perform reaction in a microscale photochemical reactor equipped with UV source under nitrogen gas protection .
	0.0%	50.0%	25.0%	25.0%	CHEM 355; Spring 2021; 4 chemistry majors; Student assessment is based on yield and purity of 3 organic syntheses.
	16.7%	33.3%	33.3%	16.7%	CHEM 355; Spring 2022; 5 chemistry majors; Student assessment is based on yield and purity of 3 organic syntheses.
Mean	**6.7%**	**26.7%**	**20.0%**	**46.7%**	

Overall Score: 2.1/3.0

Student Outcomes Assessment & Success Report Evaluation AY 21-22

Program: BS Chemistry
Evaluation: Exemplary

The purpose of SOAS Report evaluation is to promote high quality academic program assessment that results in relevant, useful, and accurate data about student learning outcome achievement that faculty can use in planning for and monitoring efforts toward continuous improvement. Faculty are encouraged to incorporate feedback they find useful into assessment practices, and resources are available to support assessment development.

Evaluation Key: Exemplary=Meets all standards, exceeds some; Mature=Meets all/most standards, no serious concerns; Developing=Meets some standards, multiple recommendations for improvement; Undeveloped=Meets few/no standards, serious concerns noted; Cannot Evaluate=Missing information prevents evaluation

Component of Practice	Areas of Exemplary Practice	Standards of Practice Highlighted practices were clear in the SOASR	Recommendations for Improvement (serious concerns highlighted)	Evaluation Relative to Standards
Learning Outcomes Strong learning outcomes use language that focuses on what students will achieve and can be measured to demonstrate achievement.		At least one outcome is assessed this cycle Outcome(s) is specific as to what students will be able to know/do as a result of their learning Outcome(s) is measurable Outcome(s) is consistent across modes of delivery (if applicable)		Mature
Assessment Strategies Strong assessment strategies are designed to produce data of high enough quality to be useful to faculty trying to understanding student learning outcome achievement, uncover potential issues, and determine next steps to support continuous improvement. They do not rise to the rigor of research methods, though they may draw on some related tenants and strategies.	Excellent use of multiple points of data across the curriculum to determine student mastery relative to expectations. Use of multi-year data in overall assessment cycle provides a more accurate analysis of student learning in the program rather than point in time or cohort based analyses.	Assessment measure(s) is designed for precise alignment to designated outcome(s) Overall assessment strategy relies primarily on direct assessment measure(s) Indirect assessment measure(s) is included to provide supplemental perspectives Assessment data comes from multiple sources, either within a significant course or across the curriculum Assessment measures include rich and/or relevant displays of student learning (i.e. experiential learning, intensive writing, problem-based learning, licensure exams, etc.) Tools for evaluating student achievement are clearly described when necessary (i.e. rubrics, exam alignment key, preceptor evaluation, etc.)		Exemplary

Results & Analysis Clear depiction of results and strong analysis pairs with strong assessment strategies to allow faculty to determine appropriate interpretation of data and use of findings. Use of student achievement data rather than anecdotes, comparison to thresholds of proficiency, and thoughtful use of disaggregation to uncover potential group differences that might exist are all good practices.	Excellent discussion of faculty insights into student performance, given relatively little variation over time. Even if variation was caused by pandemic losses, students are still consistently performing at or above expectations for mastery.	The threshold for proficiency for each outcome is clearly stated relative to the measure/evaluation tool used The threshold for proficiency reflects reasonably high expectations for the program Actual student performance data on assessment measures is shared relative to the stated threshold for proficiency and (when applicable) the evaluation tool used Thoughtful discussion of faculty insights gained from findings is included When appropriate, student performance data is disaggregated by group, without identifying any specific student (ex: on-campus & distance cohorts in a program offering both forms of delivery) When applicable, missing data or significant limitations to how data may be interpreted or applied are described		Exemplary
Continuous Improvement Assessment is about sharing and use of results to celebrate strong performance and improve in intentional ways. Assessment for continuous improvement includes engaging multiple faculty in assessment, comparing prior results to current results to examine our interventions, using findings to plan for the future, and sharing what we have learned.	Faculty involvement in assessment is clear, and plans are in place to facilitate additional faculty engagement. Chemistry's approach to assessment is strongly focused on understanding student mastery for the purposes of confirming effective teaching and support and addressing any issues. The assessment plan is well-designed to provide the needed evidence in a simplified, systematic way.	Multiple program faculty are involved in the assessment process Plans for maintaining strong performance and/or improving student learning are clearly driven by assessment findings Plans for maintaining strong performance and/or improving student learning are within reasonable purview of program faculty If data from prior assessments is provided, reflection on changes over time and the possible impact any prior interventions is discussed A commitment to ongoing assessment is demonstrated in clear plans for upcoming assessment Assessment findings are shared with program faculty and any applicable stakeholders		Exemplary

Contact Kelley Woods-Johnson at kelley.woods-johnson@indstate.edu or x7975 with questions or for support.

Outcome #3--Students pursuing a baccalaureate degree in chemistry will carry out basic laboratory procedures demonstrating appropriate use of instrumentation, quantitative measurement, and data analysis. Students were evaluated to have laboratory skills that were not acceptable (NA), fair (F), good (G), or very good (VG).

Table A4. Results of assessment for three classes and weighted mean result. The weighted mean was calculated based on the number of students in each class.

Category 2	Result				Explanation
	NA	F	G	VG	
Students are able to perform standard chemical compound purity procedures.	0.0%	0.0%	20.0%	80.0%	CHEM 340; Fall 2021; 5 chemistry majors; This assessment is based on an experiment of "Optical Isomers of $Co(en)_3^{3+}$". Students need to purify optical isomers based on their different solubility in water and measure their optical rotation.
	25.0%	25.0%	50.0%	0.0%	CHEM 355; Spring 2021; 4 chemistry majors; Student assessment is based on ability to assess purity a variety of methods.
	0.0%	33.3%	33.3%	33.3%	CHEM 355; Spring 2022; 6 chemistry majors; Student assessment is based on ability to assess purity a variety of methods.
Mean	**6.7%**	**20.0%**	**33.3%**	**40.0%**	

Overall Score: 2.1/3.0

Outcome #3--Students pursuing a baccalaureate degree in chemistry will carry out basic laboratory procedures demonstrating appropriate use of instrumentation, quantitative measurement, and data analysis. Students were evaluated to have laboratory skills that were not acceptable (NA), fair (F), good (G), or very good (VG).

Table A5. Results of assessment for three classes and weighted mean result. The weighted mean was calculated based on the number of students in each class.

Category 3	Result				Explanation
	NA	F	G	VG	
Students are able to operate standard modern chemical instruments and interpret the results.	0.0%	0.0%	50.0%	50.0%	CHEM 340; Fall 2021; 4 students This assessment is based on an experiment of "Superconductor". Students need to use tube furnace to precisely control the heating and cooling process to prepare superconductor, and use their knowledge in crystal field theory to identify the crystal structures.
	25.0%	25.0%	25.0%	25.0%	CHEM 355, Spring 21, 4 students. Titrimetric analysis nBuLi.
	0.0%	50.0%	16.7%	33.3%	CHEM 355, Spring 22, 6 students. Titration of nBuLi, Chiral LC-MS of Tartrate
Mean	**11.4%**	**22.8%**	**35.4%**	**30.4%**	

Overall Score: 2.0/3.0

Outcome #3--Students pursuing a baccalaureate degree in chemistry will carry out basic laboratory procedures demonstrating appropriate use of instrumentation, quantitative measurement, and data analysis. Students were evaluated to have laboratory skills that were not acceptable (NA), fair (F), good (G), or very good (VG).

Table A6. Results of assessment for seven classes and weighted mean result. The weighted mean was calculated based on the number of students in each class.

Category 4	Result				Explanation
	NA	F	G	VG	
Students are able to accurately carry out classical and instrumental quantitative methods of chemical analysis.	0.0%	0.0%	40.0%	60.0%	CHEM 340; Fall 21; 5 students This assessment is based on an experiment of "Synthesis and use of Wilkinson's catalyst". Students need to synthesize classic Wilkinson's catalysts and quantitatively assess the efficiency of their catalyst.
	20.0%	10.0%	30.0%	40.0%	CHEM 321L, Spring 21, 20 students. Gravimetric analysis for Cl of an unknown. Students are assessed on accuracy and precision.
	8.3%	16.7%	41.7%	33.3%	CHEM 321L, Spring 22, 12 students. Gravimetric analysis for Cl of an unknown. Students are assessed on accuracy and precision.
	10.0%	30.0%	55.0%	5.0%	CHEM 321L, Spring 21, 20 students. Titrimetric analysis for KHP of an unknown. Students are assessed on accuracy and precision.
	8.3%	33.3%	16.7%	41.7%	CHEM 321L, Spring 21, 12 students. Titrimetric analysis for KHP of an unknown. Students are assessed on accuracy and precision.
	0.0%	50.0%	25.0%	25.0%	CHEM 355, Spring 2021, 4 students. Titrimetric analysis nBuLi.
	16.7%	33.3%	16.7%	33.3%	CHEM 355, Spring 2022, 6 students. Titration of nBuLi, Chiral LC-MS of Tartrate
Mean	**11.4%**	**22.8%**	**35.4%**	**30.4%**	

Overall Score: 1.8/3.0

Outcome #3--Students pursuing a baccalaureate degree in chemistry will carry out basic laboratory procedures demonstrating appropriate use of instrumentation, quantitative measurement, and data analysis. Students were evaluated to have laboratory skills that were not acceptable (NA), fair (F), good (G), or very good (VG).

Table A7. Results of assessment for four classes and weighted mean result. The weighted mean was calculated based on the number of students in each class.

Category 5	Result				Explanation
	NA	F	G	VG	
Students are able to assess both accuracy and precision of analytical results.	0.0%	0.0%	60.0%	40.0%	CHEM 340; Fall 21; 5 students; This assessment is based on an experiment of "Preparation of cobalt salen complex and determination of oxygen absorption". Students need to synthesize cobalt complex and very precisely perform an oxygen absorption test, and calculate the oxygen uptake and predict the mechanism of oxygen adduct.
	25.0%	25.0%	50.0%	0.0%	CHEM 355, Spring 2021, 4 students. Titrimetric analysis nBuLi.
	33.3%	33.3%	16.7%	16.7%	CHEM 355, Spring 2022, 6 students. Titration of nBuLi, Chiral LC-MS of Tartrate
	0.0%	16.7%	33.3%	50.0%	CHEM 321L, Spring 22, 12 students; Students are tested on their ability to assess both accuracy and precision of analytical results given multiple data sets.
Mean	**11.1%**	**18.5%**	**37.0%**	**33.3%**	

Overall Score: 1.9/3.0

Outcome #3--Students pursuing a baccalaureate degree in chemistry will carry out basic laboratory procedures demonstrating appropriate use of instrumentation, quantitative measurement, and data analysis. Students were evaluated to have laboratory skills that were not acceptable (NA), fair (F), good (G), or very good (VG).

Table A8. Results of assessment for three classes and weighted mean result. The weighted mean was calculated based on the number of students in each class.

Category 6	Result				Explanation
	NA	F	G	VG	
Students are able to use commercially available software for scientific calculations and data analysis.	0.0%	25.0%	25.0%	50.0%	CHEM 340; Fall 21; 5 students This assessment is based on an experiment of “Ferrocene”. Students need to synthesize ferrocene, then use the state-of-the-art electrochemical measurement system to obtain its cyclic voltammogram (CV). Students need to use the equipped software to identify the redox peaks and calculate the reduction potential.
	15.8%	15.8%	42.1%	26.3%	CHEM 321L, Spring 21, 19 students Students use Microsoft Excel to calculate basic univariate statistics, hypothesis testing, and multiple calibration methods.
	0.0%	8.3%	25.0%	66.7%	CHEM 321L, Spring 22, 2 students. Students use Microsoft Excel to calculate basic univariate statistics, hypothesis testing, and multiple calibration methods.
Mean	**8.6%**	**14.3%**	**34.3%**	**42.9%**	

Overall Score: 1.9/3.0

Table A9. Summary results of assessment for six categories of laboratory skills and the weighed mean result for each of the six categories. The weighed grand mean is based on the six categories and is weighed on the basis of total number of students assessed in each category.

Summary	Result

	NA	F	G	VG
(1) Students are able to synthesize moderately complex compounds using contemporary techniques.	6.7%	26.7%	20.0%	46.7%
(2) Students are able to perform standard chemical compound purity procedures.	6.7%	20.0%	33.3%	40.0%
(3) Students are able to operate standard modern chemical instruments and interpret the results.	6.3%	25.0%	31.3%	37.5%
(4) Students are able to accurately carry out classical and instrumental quantitative methods of chemical analysis.	11.4%	22.8%	35.4%	30.4%
(5) Students are able to assess both accuracy and precision of analytical results.	11.1%	18.5%	37.0%	33.3%
(6) Students are able to use commercially available software for scientific calculations and data analysis.	8.6%	14.3%	34.3%	42.9%
Weighed grand mean	8.4%	21.2%	31.9%	38.5%

Overall Score: 2.0/3.0

Outcome #4— Students pursuing a baccalaureate degree in chemistry will be able to demonstrate professional communication skills.

Table A10. Results of assessment for written and oral communication skills and weighed mean result. Students were assessed to be not acceptable (NA), fair (F), good (G), or very good (VG). The weighed mean was calculated based on the number of students in each course.

Category 1	**Result**				**Explanation**
	NA	F	G	VG	
Written communication					
	9.1%	45.5%	34.4%	9.1%	CHEM 341; Spring 2022; 11 chemistry majors; Students assessment is based on a question on the Final, which requires students to draw band structure for a semiconductor, and then use this band structure to explain how the conductivity changes with increasing temperature.
	15.4%	30.8%	38.5%	15.4%	CHEM 405; Fall 2020; 13 chemistry majors; Student assessment is based on two written abstracts that correspond to oral presentations on a specific topic in chemistry.
	6.7%	20.0%	53.3%	20.0%	CHEM 405; Fall 2021 15 chemistry majors; Student assessment is based on two written abstracts that correspond to oral presentations on a specific topic in chemistry.
	0.0	33.3%	0.0%	33.3%	CHEM 405; Spring 2022; 3 chemistry majors. Student assessment is based on two written abstracts that correspond to oral presentations on a specific topic in chemistry.
	100.0%	0.0%	0.0%	0.0%	CHEM 300; Spring 2021; 1 student; Two-page paper addressing topics from a biochemistry journal article that we discussed in class over the course of the semester.
Grand mean	11.6%	30.2%	39.5%	18.6%	

Overall Score: 1.7/3.0

Outcome #4— Students pursuing a baccalaureate degree in chemistry will be able to demonstrate professional communication skills.

Table A11. Results of assessment for written and oral communication skills and weighed mean result. Students were assessed to be not acceptable (NA), fair (F), good (G), or very good (VG). The weighed mean was calculated based on the number of students in each course.

Category 2	**Result**				**Explanation**
	NA	F	G	VG	
Oral communication	0.0%	0.0%	16.7%	83.3%	CHEM 340; Fall 2021; 6 chemistry majors; Student assessment is based on the final poster session. Each student was required to make a poster to present one of experiment she/he did during the semester. Departmental faculty and students were invited to visit the poster and ask questions.
	7.7%	30.8%	46.2%	15.4%	CHEM 405; Fall 2020; 13 chemistry majors; Student assessment is based on two Powerpoint presentations on a specific topic in chemistry.
	7.1%	28.6%	57.1%	7.1%	CHEM 405; Fall 2021 15 chemistry majors; Student assessment is based on two Powerpoint presentations on a specific topic in chemistry.
	7.7%	30.8%	46.2%	15.4%	CHEM 405; Spring 2022; 3 chemistry majors; Student assessment is based on two Powerpoint presentations on a specific topic in chemistry.
Grand mean	6.1%	24.2%	45.5%	24.2%	

Overall Score: 1.9/3.0