Student Outcomes Assessment and Success Report AY2020-21 ***Consult with your college dean's office regarding due date and how to submit. Deans will submit reports to the Office of Assessment & Accreditation annually by October 15.***

Unit/Program Name: _Chemistry_ **Contact Name(s) and Email(s)** _Stephen F. Wolf, stephen.wolf@indstate.edu_____

Part 1a: Summary of Student Learning Outcomes Assessment

NOTE: If data is missing due to COVID-19 transition issues, please describe these issues, their impact on your ability to assess student learning, and what, if anything, will change as a result.

a. What learning outcomes did you assess this past year?	**b. (1) What assignments or activities did you use to determine how well your students attained the outcome? (2) In what course or other required experience did the assessment occur?**	**c. What were your expectations for student performance?**	**d. What were the actual data/results?**	**e. What changes or improvements were made or will be made in response to these assessment results or feedback from previous year's report?** *Can expand on this in Part 2.*
Outcome #1 – Students pursuing a baccalaureate degree in chemistry will exhibit a sound grasp of ***fundamental concepts*** in the discipline.	(1) A total of 30 Chemistry majors in two cohorts were assessed this cycle in the category of ***fundamental concepts*** by taking a 2-hr long Major Fields Test near the end of the Fall semester of their senior year (2019 and 2020). This exam tests knowledge of fundamental concepts in the subdisciplines of physical, organic, inorganic, and analytical chemistry. Students receive a score for each subdiscipline, a total score, and a percentile ranking based on their total score and total scores from students from multiple institutions. (2) This exam was given as part of our CHEM 405 Senior Seminar course which students take in the Fall semester of their senior year.	In the previous cycle when Outcome #1 was last assessed (AY 18-19), our stated expectation for student performance was that the class mean overall rank will be above the 50th percentile of all students taking the exam at multiple Colleges and Universities. Here, we assess a student as performing not acceptable (NA) if they score <25th percentile, fair (F) if between 25th and 50th percentile, good (G) if between 50th and 75th percentile, or very good (VG) if >75th percentile. We have altered our criteria for acceptable to be 50% of students scoring fair (F) or better.	For this cycle, total scores for the past two academic years were compiled and a mean calculated for the two cohorts. Our expectations have been that > 50% are assessed as performing fair (F) or better. Results for the Fall 2019 and Fall 2020 cohorts show ~47% students are performing at an "F" or better level with ~27% performing at the "G" to "VG" level. ~53% of students scored "NA." Unfortunately, these results do not meet our expectations of >50% of students receive an assessment of "F" or better. Results from the Fall 2017 and Fall 2018 cohorts show that the last time we assessed this learning outcome, 67% of students met our expectations. The decrease of 67% to 47% from the previous assessment cycle to the current cycle is concerning and needs to be addressed. Detailed results and 9-year trends for this outcome are given in Appendix A.	The apparent downward trend of student performance on this exam has been discussed in meetings of an ad hoc committee of chemistry faculty. The overall consensus was this decrease is most likely due to multiple factors, one of which is the inclusion of data from students who did not take our General Chemistry sequence (CHEM 105 & 106). A sizable (and possibly increasing) fraction of our students take these courses elsewhere, most often from community colleges, and receive transfer credit. We have been concerned for many years about how these transfer courses measure up to our own courses, because students who take the courses at community colleges often are underprepared in certain ways for their subsequent chemistry coursework at ISU (e.g., organic and analytical chemistry). Because this exam requires ***problem solving skills*** (see Outcome #2 below), one way to attempt to reverse the downward trend would be to increase our efforts to improve

				problem solving skills by incorporating more and/or innovative problem solving opportunities into our courses. Discussions among the chemistry faculty and academic advisors will continue to address this issue.

a. What learning outcomes did you assess this past year?	**b. (1) What assignments or activities did you use to determine how well your students attained the outcome? (2) In what course or other required experience did the assessment occur?**	**c. What were your expectations for student performance?**	**d. What were the actual data/results?**	**e. What changes or improvements were made or will be made in response to these assessment results or feedback from previous year's report?** *Can expand on this in Part 2.*
Outcome #2— Students pursuing a baccalaureate degree in chemistry will employ ***problem solving skills*** together with scientific models and mathematical techniques to explain and predict behavior of chemical systems.	(1) Seven instructors teaching lecture and laboratory courses spanning a wide range of subdisciplines completed rubrics in one or more of seven separate categories appropriate to their subdiscipline. (2) Courses, assignments, and required experiences used to determine the assessment outcomes are detailed in Appendix B. They range from sophomore-level to senior-level courses.	In the previous cycle when Outcome #2 was assessed (AY 18-19) our stated expectations for this cycle were that on average 2/3 of the students will perform at a level of "Fair" or better.	Weighed mean results for each problem-solving category, as well as a weighed grand mean across all categories, show that ~91% of students are performing at a "Fair" or better level, with ~67% performing at the "Good" or "Very Good" level. These results meet our expectations. Results are detailed in Appendix B.	In a previous assessment of this outcome (2018-2019) it was observed that electronic homework programs might be detrimental because they encourage students to solve problems mechanistically without long-term retention of the material. In fact, many students do not attempt to solve these problems, but simply perform an online search for the answer to each question. We hope that as these electronic homework programs become more "mature," they will be modified by the publishers in ways that will make them better educational tools. In the meantime, chemistry faculty will be encouraged to use electronic homework strategically and to incorporate "traditional" problem solving opportunities into their courses as much as possible. This will include homework or in-class exercises where students must reason out the answer to a problem (be it mathematical, synthetic, etc.) in a step-by-step fashion and document the steps of the process in writing. For this cycle we attempted to improve our assessment of problem solving skills by increasing the sampling size and the scope of the categories being assessed.

Note: *If you would like to report on more than three outcomes, place the cursor in the last cell on the right and hit "tab" to add a new row.*

Helpful Hints for Completing this Table

a. Use your outcomes library as a reference. Note any alignment with professional standards, as applicable.
b. Each outcome should be assessed by at least one direct measure (project, practica, exam, performance, etc.). If students are required to pass an examination to practice in the field, this exam should be included as one of the measures. At least one of the program's outcomes must use an indirect measure (exit interview, focus group, survey, etc.). Use your curriculum map to correlate outcomes to courses. Describe or attach any evaluation tools such as rubrics, scales, etc.
c. Identify the score or rating required to demonstrate proficiency (e.g., Students must attain a score of "3" to be deemed proficient; at least 80% of students in the program will attain this benchmark.)
d. Note what the aggregate level of proficiency actually was and the number of students included in the cohort or sample (e.g., 85% of the 25 students whose portfolios were reviewed met the established benchmark).

Part 1b: Review of Student Success Data & Activities

Use Blue Reports to generate the following information (as well as any other information helpful to you). A dashboard has been created in the Chairs view:

1) Cohort Sizes

	Fall 2017	Fall 2018	Fall 2019	Fall 2020
Chemistry (1421)	85	93	85	62

2) Year-to-Year Retention

	Fall 2014		Fall 2015		Fall 2016		Fall 2017		Fall 2018		Fall 2019		Fall 2020	
	Cohort Total	Cohort Retention %	Cohort Total	Cohort Retention %	Cohort Total	Cohort Retention %	Cohort Total	Cohort Retention %	Cohort Total	Cohort Retention %	Cohort Total	Cohort Retention %	Cohort Total	Cohort Retention %
College of Arts & Sciences	828	63.89%	871	64.52%	809	68.11%	851	62.04%	816	67.16%	641	70.05%	653	60.80%
Chemistry (1421)	12	50.00%	15	73.33%	6	50.00%	14	64.29%	15	53.33%	16	81.25%	9	66.67%

3) 5-Year Graduation Rate (undergraduate)

	Cohort Total	Cohort Graduation %	Cohort Total	Cohort Graduation %	Cohort Total	Cohort Graduation %	Cohort Total	Cohort Graduation %	Cohort Total	Cohort Graduation %	Cohort Total	Cohort Graduation %
College of Arts & Sciences	808	36.01%	780	39.36%	824	37.86%	839	36.47%	828	36.84%	871	40.87%
Chemistry (1421)	13	38.46%	13	23.08%	12	58.33%	18	55.56%	12	33.33%	15	53.33%

What worked well in supporting student success this year?

Despite restrictions due to the pandemic, we were able to safely provide laboratory experiences in face-to-face, hands-on format for all majors-level CHEM 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. As usual, we provided free tutoring for freshman and sophomore-level chemistry at the Science Help Center. Face-to-face hours had to be limited due to the pandemic, so Zoom tutoring was provided instead.

What are the most significant opportunities for improvement upon which to focus in the coming year?
In the coming year we are hoping that CHEM 405 will be approved as a new High Impact Practices (HIP) course for the Foundational Studies Program. We plan to make modifications to this capstone course which we hope will have a positive impact on students' career readiness, written communication skills, critical thinking, and scientific information literacy.

Part 2: Continuous Quality Improvement

Reflect on the information shared above regarding student learning, success, and career readiness. In no more than one page, summarize:

1) **the discoveries assessment and data review have enabled you to make about student learning, success, and career readiness** (ex: What specifically do students know and do well—and less well? What evidence can you provide that learning is improving? How might learning, success, and career readiness overlap? What questions do your findings raise?)
2) **findings-based plans and actions intended to improve student learning and/or success (expansion of Part 1a, box e as needed)**
3) **what your assessment plan will focus on in the coming year**
4) **how this information will be shared with other stakeholders**

1) For Outcome #1 (fundamental concepts), we observed a downward trend in performance, so this data does not provide evidence that learning is improving. On the other hand, for Outcome #2 (problem solving skills), there was an increase in the percentage of students who performed at or above the "fair" level (91%) in the current assessment cycle compared to the previous assessment cycle (80%). It is possible that this apparent increase is simply due to some changes in our assessment process for this cycle—specifically, an increase in the sample size and scope of the data collected, as noted in Part 1a, box e, above. We describe below in 3) how we plan to make further improvements in the assessment process so that we can better evaluate trends in the data from cycle to cycle.

The downward trend noted for Outcome #1 (fundamental concepts) is concerning and we intend to address it as described in Part 1a. However, we cannot say that performance below the "fair" level by a given student on the Major Fields Test necessarily means the student is not "career ready" and will not be successful on the job. In fact, the chemistry faculty can name many "average" students from recent years who have gone on to be successful at entry-level jobs in the chemical industry. They receive on-the-job training that may make up for any deficit in background knowledge. Other traits, such as adaptability, persistence, and willingness to learn new skills, seem to be highly determinant of ultimate career success. We believe the Chemistry Program helps students develop those traits due to the challenging nature of the upper-level courses along with the highly supportive environment created by our advisors and faculty.

The ability to solve problems is an absolutely essential skill in the field of chemistry, so it correlates with readiness for a career in chemistry. Strong problem solving skills cannot be developed in a single course or at the very end of students' academic careers. Thus, it is important that all the chemistry faculty continue to strive to incorporate problem solving exercises into their courses at all levels and as often as possible.

2) As noted in Part 1a, box e, above: To foster problem solving skills in our students, chemistry faculty will be encouraged to treat electronic homework with caution and make strategic use of it in their courses. They will be encouraged to incorporate "traditional" problem solving exercises into their courses as much as possible, both during class and on homework assignments. We have reason to believe this will be a worthwhile endeavor, because our physics colleagues have seen positive results from "traditional" problem solving exercises where students are taught strategies and must document their steps for solving a problem (as described in the Physics Assessment Report for this cycle). We hope that a greater emphasis on problem solving skills in various courses will translate into improved scores on the Major Fields Test (Outcome #1, fundamental concepts).

3) Next year we will assess Outcome #3 (laboratory procedures) and Outcome #4 (written and oral communication skills). Along with providing these assessments we plan on making a few minor changes to improve our overall assessment process by better facilitating the faculty data collection process and standardizing data evaluation across all four of our outcomes. Improvement in data collection will be achieved by providing faculty better guidance about the information being sought and the ancillary data required for subsequent analysis. Improvement in data evaluation will be achieved, in-part, by formalizing the NA, F, G, VG categories

and developing a single numerical metric that will allow us to conclude whether an overall result is satisfactory or unsatisfactory. Such an approach should facilitate evaluating trends in our assessment data. We propose to use this method for our next assessment cycle.

4) Upon completion this report will be submitted to the Chair of the Department of Chemistry and Physics (Jennifer Inlow) who will, upon her approval, forward it to the Dean of the College of Arts and Sciences and subsequently to the Office of Assessment for review. Upon approval, information contained in this assessment report will be discussed at a departmental faculty meeting. The report will be uploaded to our departmental Blackboard site to make it accessible by all chemistry faculty at any time. Feedback received from the Office of Assessment will also be addressed at future departmental assessment committee meetings and departmental faculty meetings. Interested faculty will be encouraged to assist in gathering data for future assessment cycles.

Thank you so much for sharing your assessment process and findings for AY 2020-21 with the Assessment Council. You will find feedback and ratings on the rubric below. It is understood that some of the feedback might encompass practices that you already engage in but were not documented in this report. As the purpose of this evaluation is focused on recognizing great work and helping faculty improve assessment practice, it is not necessary to retroactively add documentation. Please feel free to let me know if you have any questions or if there is any way I can assist you in further developing assessment practice and use in your program.

This report will be shared with the Associate Dean(s) and Dean of your college and summarized findings will be shared as composite college/institutional data with the President's Office and the Provost's team.

Sincerely,

Kelley (x7975)

Program: Chemistry B.S.	**Overall Rating: Exemplary (3.00/3.00)**
Strengths	**Recommendations**
• Assessment in Chemistry continues to be an exemplar of practice at ISU. • Learning outcomes are clear, specific, and measurable. • Measures include the Major Field Test and problem solving activities to provide direct insight into student knowledge and application of knowledge to problem-solving scenarios. • Detailed descriptions of evaluation of student performance on measures are included, providing support for the quality of inferences that can be made from the data. • Detailed descriptions are provided for expectations for student performance, including a shift to refine expectations to provide a more granular understanding of students who exceed expectations and to what degree. • Actual findings are clearly described with reference to the standards set in expectations. • Thoughtful discussion is offered about possible reasons for student achievement falling short of or exceeding expectations, including challenges faculty face with quality of transfer credit and student opportunities for problem solving. Strategies are offered to deepen problem-based learning throughout the Chemistry curriculum, as well as borrowing from proven successful techniques in the Physics curriculum.	•

• Clear information is provided about ongoing cycle of assessment, as well as how assessment is a shared endeavor by department faculty. • Clear information is provided about how assessment is shared and used.	

Student Outcomes Assessment & Success Report Rubric **Unit/Program: Chemistry B.S.**
Office of Assessment & Accreditation, Indiana State University **Evaluation Date: Fall 2021**

Evaluation Criteria	3 Exemplary	2 Mature	1 Developing	0 Undeveloped
Student Learning Outcomes	Identified, aligned learning outcomes are specific, measurable, student-centered, and program-level. Outcomes directly integrate institution or college-level learning goals. Outcomes are consistent across modes of delivery (if applicable). More than one outcome is assessed this cycle, and rationale is provided for why they were selected for assessment.	Identified, aligned learning outcomes are specific, measurable, student-centered, and program-level. Outcomes support institution or college-level learning goals. Outcomes are consistent across modes of delivery (if applicable). At least one outcome is assessed this cycle.	Learning outcomes are identified and alignment with courses is demonstrated. Outcomes are consistent across modes of delivery (if applicable). At least one outcomes is assessed this cycle.	No learning outcomes are identified, and/or alignment of learning outcomes to courses is not demonstrated (e.g. – curriculum map).
Performance Goals & Measures	Performance goals are clear and appropriate, and rationale is provided for why these were selected. Identified measures and tools are assigned to each outcome, are clear and intentionally designed to address student performance on aligned outcomes, and rationale and examples are provided (e.g. – rubrics, checklists, exam keys). Most are direct measures, and their design enhances the validity of findings. Licensure exams and high-impact practices are reflected in measures (if applicable).	Performance goals are clear and appropriate. Identified measures and tools are assigned to each outcome, are clear and intentionally designed to address student performance on aligned outcomes, and examples are provided (e.g. – rubrics, checklists, exam keys). At least one direct measure is included.	Performance goals are identified with little rationale or clarity. Identified measures are poorly suited to performance goals, underdeveloped, or are solely indirect measures.	No goals for student performance of learning outcomes are identified, and/or no measures are provided.

Analysis & Results	Data collection process is clear and designed to produce valid/trustworthy results. The process is useful to those collecting and/or interpreting data. Data is collected and analyzed with clear rationale and description. Results are provided with thoughtful discussion of analysis and description of conclusions that can be drawn.	Data collection process is clear and designed to produce valid/trustworthy results. Data is collected and analyzed with clear rationale and description. Results are provided with some discussion of analysis.	Description of data collection is unclear as to process and quality. Some data is collected and analyzed with little rationale or description. Some results are provided with no discussion of analysis.	No information is provided about the data collection process, and/or no data is being collected. No results are provided.
Sharing & Use of Results for Continuous Improvement	A plan for sharing information and included program faculty and appropriate staff in discussion and planning is detailed and enacted. Outcomes and results are easily accessible on the program website or other appropriate designated area. Plans for improvement or change based on results are clear and connected to results. If few students met performance goals, this is included in discussion and plans. Reflection if offered about results or plans moving forward, and compares prior year plans to current outcomes in an effort to foster continuous improvement as a result of assessment process.	A plan for sharing information broadly across program faculty is detailed and enacted. Plans for improvement or change based on results are clear and connected to results. If few students met performance goals, this is included in discussion and plans. Reflection is offered about results or plans moving forward.	Information is provided about sharing results, but sharing is limited in scope or content. Plans for improvement or change based on results are incomplete, vague, or not clearly connected to results. Little reflection is offered about results or plans moving forward.	No information is provided about sharing results and/or plans for improvement or change based on results. No evidence of reflection on results in provided.
Overall Rating	□ **Exemplary**	□ **Mature**	□ **Developing**	□ **Undeveloped**