2.1.1.2.2 Laboratory Design

Our second PLO is related to the design of laboratory experiments. Our old assessment protocol involved counting the number of students who participated in summer research. It was an inputs-based metric and did not give us any idea of whether students were meeting our desired outcomes. Since our last six-year report, we have adopted a new assessment tool[1] for direct assessment of student learning. This was first used in our 2018 Annual Report. We have only used this tool once, but because it is outcomes-based, we find it much more useful for the assessment of student learning than our previous inputs-based assessment.

When evaluated by two professors according to the published rubric, our students did not quite meet our departmental benchmark—they scored an average of 22.6 out of 36 when our benchmark is 24 out of 36. That particular year had an unusually small number of students participating in the course in which the assessment was conducted. Moreover, because of individual circumstances, most of them were juniors and had not yet been through our full laboratory sequence. So, although our students did not meet the benchmark, we learned a lot about how to improve our evolving process for assessing student learning in the area of laboratory design. Specifically, the next time we assess this PLO we will make sure it is in a course (perhaps CHM-133 or CHM-195) that is mostly seniors. As described in our 2018 annual report, we are committed to making several other changes at the curricular level that we hope will improve our students' ability to think like scientists in the context of designing experiments.

This is still a work in progress. We are currently undergoing significant work in light of new data on the performance of first-generation and underrepresented minority students in General Chemistry, and we are currently using data we collected to answer this Key Question in 2017 to improve our support for the learning of all students in General Chemistry.

[1] Shadle, S. E.; Brown, E. C.; Towns, M. H.; Warner, D. L., A Rubric for Assessing Students' Experimental Problem-Solving Ability. *Journal of Chemical Education* 2012, 89(3), 319-325.

5.4.2 Experimental Design

The rubric for our Experimental Design PLO comes from Figure 1 of Shadle, et al.[8] It is reproduced below.

Criterion 1. Identifies the important or relevant features of the problem. For each practicum question, students will be provided a problem. This dimension is related to student identification of the important issues that must be considered in order to solve the presented problem.			
Emerging		*Developing*	*Mastering*
1	2	3	4
Does not attempt to or fails to identify the important aspects of the problem… clueless.	Identifies a small percentage of the important features of the problem to be solved.	Identifies some of the important features of the problem.	Clearly demonstrates an understanding of the problem, addressing important aspects of the problem that must be considered.
Criterion 2. In formulating a strategy for the solution of the problem, student presents a complete justification or explanation for the strategy. This dimension focuses on the ability of the student to back up the choice of strategies with appropriate reasoning and factual, procedural, or conceptual knowledge. This dimension also deals with the completeness of one's strategy.			
Emerging		*Developing*	*Mastering*
1	2	3	4
Strategy is incomplete and/or lacks justification.	Justification is provided for most or all components of the strategy, but the reasoning is limited to the most basic information.	Provides a complete explanation with reasons for choosing the components of the strategy.	Includes all reasons for choosing the components of the strategy, and also includes caveats and reasons not to choose alternative strategies.
Criterion 3. Provides an effective strategy that is likely to work to solve the chemical problem. This dimension focuses on the correctness of the strategy a student chooses to address the problem: would it work? This strategy also deals with student identification of reasons it may not work.			
Emerging		*Developing*	*Mastering*
1	2	3	4
The data to be collected will provide limited information for solving the stated problem.	The data to be collected are likely to provide insight into the stated problem, but the results will be less than definitive. Student appears to have made some unstated assumptions.	Data to be collected are likely to yield definitive results, leading to an unambiguous answer to the stated question.	Data to be collected are likely to yield definitive results, leading to an unambiguous answer to the stated question. In addition, answer includes information about why the strategy may not work. Answer may also indicate back-up strategies that could be employed.