Program Student Learning Outcome (PSLO) Assessment Reporting Template 2016-2017

[For further guidance on this process, see the PSLO Assessment How-To Guide on the TLC website]

Program: Chemistry Semester: Fall/Spring (2016-2017)

Faculty/Staff Assessing the Program: Dennis Gravert and Mindy Capes

Part 1: Assessment Goals

What do you want to learn about your students and their learning from this process?

- What is/are your research question(s)? Why is this research question significant to your program?

Our research questions are:

1) To what extent are our graduates prepared for the work needed at a transfer institution to complete their degree in Communication?
2) What can we do to improve program effectiveness and/or student learning in the department?

The goal behind our research questions is to improve transfer/completion rates and evaluate what is working or not working well in our instructional/program design.

Part 2: Assessment Plan

PSLO	Method of Assessment	Proficiency Criteria	Student Population Assessed
Enter all the PSLOs for your program below. (Additional rows may be needed)	**Identify and describe the assessment activity** (capstone project, portfolio, interview, pre/post survey, analysis of success rates, etc) used to assess the students' proficiency of the PSLO. Explicitly state which part of the assessment activity assessed a particular PSLO.	**List the criteria you used to determine proficiency levels for each of your PSLOs.** How did you determine "needs improvement," "meets proficiency," or "exceeds proficiency" criteria?	**Describe which student populations you assessed and how you chose those populations.** How many students did you assess? To what extent did the sample adequately represent all students in the program? Why did you choose this particular group for this particular PSLO? Explain.
PSLO _1_ : Applied scientific methodology, in all its explicit steps, to either: • solve a complex problem posed in the classroom, or • complete a significant laboratory analysis, or	Assessment Activity: selected problems from CHEM-025 Exam 1 Description: Exam 1 included questions asking students to apply the scientific method to a complex problem. Students answer questions such as, "For the following question provide a good hypothesis; describe an experiment to test your hypothesis; what result(s) would disprove your hypothesis; what result(s) would support your hypothesis? Does the level of vitamin C in citrus fruit change the pH?"	High Proficiency: A-level student work provides evidence that the student can apply the scientific method steps to plan and analyze experimental work. This includes designing and describing the necessary experimental method to obtain data; analyzing data; and clearly communicating the correct conclusions. Meets Proficiency: B/C-level student work demonstrates a competent level of problem solving ability and ability to apply the scientific method. The work contains elements as outlined in A-level student work but suffers from several errors of logic or application. The work	A total of 76 students enrolled in two of the fours sections of CHEM-025 during the Fall 2016 term. This sample is approximately half of the students enrolled in the first course of the program; this course includes a significant and detailed discussion of the scientific method and steps. This population accounts for all of the students enrolled in this course with a full-time instructor. **PLAN** CHEM-025 data from Fall 2016 will be analyzed for 2 sections.

		provides evidence that the student grasps major concepts and scientific methodology; however, the complete and correct solution is missing.	
PSLO _2_ : Solved problems concerning the atomic and molecular structure of matter, using the periodic table plus quantum mechanics as the organizing and predictive models for this analysis.	Assessment Activity: selected problems from Exam #1 Description: Exam #1 included one question covering the concepts of the quantum mechanical model, 3 questions asking students to apply the quantum mechanical model to solve atomic structure problems, and 2 questions asking students to apply the quantum mechanical model to the Periodic Table.	High Proficiency: A-level student work demonstrates a thorough understanding of the quantum mechanical model. The work provides evidence that the student knows the corresponding terms and concepts and that the student can skillfully apply this knowledge to solve problems dealing with atomic structure and the Periodic Table with a minimum of minor errors. Meets Proficiency: B/C-level student work demonstrates an adequate understanding of the quantum mechanical model. The work provides evidence that the student has knowledge of key concepts, but some concepts are not understood completely or not applied correctly. A large part of the student work is on track, but it is flawed by missing or incorrect elements that prevent the student from reaching a full and correct solution.	A total of 28 students enrolled in one of the two sections of CHEM-025 during the Fall 2014 term. This sample is approximately half of the students enrolled in the first course of the program; this course includes a significant and detailed discussion of atomic models and quantum mechanics. This population accounts for all of the students enrolled in this course with a full-time instructor. **PLAN** Analysis of CSLO data from CHEM-025 2014-15 assessment of CSLO2 "Apply the quantum mechanical model of the atom to solve problems dealing with atomic structure and the Periodic Table of Elements."
PSLO _3_ : Solved stoichiometric problems, including those complicated by the presence of limiting reagents.	Assessment Activity: selected problems from exams and lab reports. Description: Mindy Capes analyzed data from the Fall 2014 semester of Chem 25. Scores from one question on the third exam specifically targeting stoichiometric calculations with a limiting reagent were analyzed. Dennis Gravert analyzed data from the Fall 2014 semester of Chem 28 Organic Chemistry. Specifically he reviewed scores from 3 lab reports which involved	High Proficiency: A-level student work demonstrates a highly trained level of problem solving ability. The work provides evidence that the student can distinguish relevant from irrelevant information, apply appropriate course concepts, carry out the mathematical and/or logical steps to obtain a solution, and interpret the solution in the context of the problem. Meets Proficiency: B/C-level student work	A total of 78 students enrolled in either CHEM-025 or CHEM-028 during the Fall 2014 term. This sample is approximately half of the students enrolled in the program course. These student populations were assessed because one of the courses (CHEM-025) in the first in the sequence of courses and is where students are initially introduced to these concepts and problems. While the other (CHEM-028) is a student population close to the completion of the program. **PLAN**

	stoichiometric calculations, and he determined the level of proficiency based on those scores.	demonstrates a competent level of problem solving ability. The work contains elements as outlined in A-level student work but suffers from several errors of logic or application. The work provides evidence that the student grasps major chemical concepts and methods of problem solving; however, the complete and correct solution is missing.	Analysis of CSLO data from CHEM-025 2014-15 assessment of CSLO1 "Solve a variety of qualitative and quantitative problems dealing with chemical concepts such as the naming of compounds, acid/base reactions, precipitation reactions, and the properties of gases."
PSLO _4_ : Correctly predicted the products of standard inorganic, organic, biochemical, or nuclear reactions.	Assessment Activity: selected problems from the Final exam. Description: Dennis Gravert analyzed data from the Spring 2012 Final exam of Chem 29. The final exam contained many questions involving chemical reactions and outlining synthetic organic sequences. The level of proficiency was determined by analyzing the scores earned on such questions.	High Proficiency: A-level student work demonstrates a highly trained level of problem solving ability. The work provides evidence that the student can apply appropriate course concepts, thoroughly understands the principles of organic reactions, and can carry out the logical steps to obtain a solution to a multi-step organic synthesis problem. Meets Proficiency: C-level student work demonstrates a competent level of problem solving ability. The work contains elements as outlined in A-level student work but suffers from several errors of logic or application. The work provides evidence that the student understands some reaction concepts and methods of problem solving; however, the complete and correct solution is sometimes missing, and s/he is generally not able to solve problems in organic synthesis.	There was only one section of Chem 29 in Spring 2012, and all 34 students took the Final exam. This course is the highest-level of chemistry offered at LMC, so in some way it serves as our capstone course. This cohort of students have experienced LMC Chemistry for the longest time, and assessment data gives a sense of how our program teaches the general topic of chemical reactions throughout our program. **PLAN** Analysis of CSLO data from CHEM-029 2012-13 assessment of CSLO1 "Predict the products of chemical reactions involving aromatics, alcohols, ethers, aldehydes, ketones, carboxylic acids & derivatives, carbonyl substitution & condensation reactions, and use this skill set to successfully outline synthetic organic sequences."
PSLO _5_ : Applied the principles of thermodynamics and kinetics to solve problems: • involving energy and entropy changes characteristic of chemical and physical reactions • concerning rates and mechanisms of chemical reactions • involving the principles of equilibrium	Assessment Activity: selected problems from Exam 1 & 3. Student-driven laboratory activity. Description: Exams 1 and 3 included 3 and 2 questions respectively, applying an understanding of chemical kinetics and reaction rates to solve problems dealing with energy and entropy. Exam 3 included 2 questions applying the laws of thermodynamics. A special laboratory project was conducted requiring students design, conduct, and finally report on a kinetic system of their choice.	High Proficiency: A-level student work demonstrates a thorough understanding of thermodynamics and kinetics as presented in this course. The work provides evidence that the student knows the corresponding terms and concepts and that the student can skillfully apply this knowledge to solve problems with a minimum of minor errors. Meets Proficiency: B/C-level student work demonstrates an adequate understanding of thermodynamics and	A total of 25 students enrolled in one of the two sections of CHEM-026 during the Fall 2015 term. This sample is approximately half of the students enrolled in the second course of the program; this course includes a significant and detailed discussion of thermodynamics and kinetics. This population accounts for all of the students enrolled in this course with a full-time instructor. **PLAN** Analysis of CSLO data from CHEM-026 2015-16 assessment of CSLO2 "Apply the laws of thermodynamics and an

		kinetics. The work provides evidence that the student has knowledge of key concepts and definitions, but some concepts are not understood completely or not applied correctly. A large part of the student work is on track, but it is flawed by missing or incorrect elements that prevent the student from reaching a full and correct solution.	understanding of chemical kinetics to solve problems dealing with energy, entropy, and rates of reactions."
PSLO _6_ : Demonstrated an understanding of electromagnetic radiation (i.e., light energy) and its interactions with matter, by carrying out spectroscopic analyses of atoms and compounds.	Assessment Activity: Lab report on NMR spectroscopy. This lab exercise involving an essential laboratory instrument will require students to analyze and interpret spectroscopic data of compounds (specifically NMR spectroscopy). Description: Dennis Gravert analyzed data from the laboratory component of Chem 29 from Spring 2012. The data consisted of a 3-5 page report submitted by each student detailing the observations, analysis, and conclusions of an experimental project using NMR spectroscopy.	High Proficiency: A-level student work in the laboratory provides evidence that the student can safely and accurately plan, conduct, and analyze experimental work on a chemical problem. This includes designing and describing the necessary experimental method to obtain data; collecting, organizing, and analyzing the laboratory data of sufficient number and relevance; and clearly communicating the results and correct conclusions of the experimental work. Overall, the work displays excellent scientific reasoning and laboratory skills, and a deep appreciation of the need to be a good "steward" of the lab instruments. Meets Proficiency: C-level student work demonstrates a proficient level of laboratory skills. Laboratory reports contain all required elements (description of experimental method, listing of experimental data, analysis of data, and discussion of results and conclusions); however, the elements contain some degree of technical error, incompleteness, evidence of misunderstanding of safety principles, or demonstration of insufficient concern for the technical fragility of the lab instruments.	There was only one section of Chem 29 in Spring 2012, and all 34 students submitted an NMR lab report. This course is the highest-level of chemistry offered at LMC, so in some way it serves as our capstone course. This cohort of students have experienced LMC Chemistry for the longest time, and assessment data gives a sense of how our program teaches the general topic of spectroscopy (how light interacts with matter). **PLAN** Analysis of CSLO data from CHEM-029 2012-13 assessment of CSLO 3: Perform laboratory analyses of compounds using modern qualitative and quantitative methods, including the use of chromatographic and spectrometric instruments.

PSLO _7_ : Conducted laboratory or field analyses using modern, professional technologies, selected from colorimetric, titrimetric, gravimetric, electrochemical, spectrometric, and chromatrographic equipment and instruments.	Assessment Activity: Selected laboratory experiments. Description: CHEM-026 - Two laboratory experiments dealt with quantitative analysis of ionic compounds, one with qualitative spectrometric analysis, and one with quantitative and qualitative analysis using electrochemical cells. CHEM-029 – One laboratory experiment required students to complete a 3-5 page report detailing the observations, analysis, and conclusions of an experimental project using NMR spectroscopy.	High Proficiency: A-level student work in the form of laboratory reports provides evidence that the student can plan, conduct, and analyze experimental work on a chemical problem. This includes designing and describing the necessary experimental method to obtain data; collecting, organizing, and analyzing the laboratory data of sufficient number and relevance; and clearly communicating the results and correct conclusions of the experimental work. Overall, the work displays excellent scientific reasoning and laboratory skills. Meets Proficiency: C-level student work demonstrates a proficient level of laboratory skills. Laboratory reports contain all required elements (description of experimental method, listing of experimental data, analysis of data, and discussion of results and conclusions); however, the elements contain some degree of inconsistency, irrelevancy, and/or incompleteness.	A total of 24 students enrolled in one of the two sections of CHEM-026 during the Fall 2015 term, and 34 students enrolled in the one section of CHEM-029 in during the Spring 2012 term. Chem 26 is the second course of the one-year sequence of General Chemistry, and Chem 29 is the second course of the one-year sequence of Organic Chemistry. Thus students in Chem 26 and Chem 29 have much experience with LMC Chemistry, and assessment data from these students can inform us from a program-level perspective. **PLAN** Analysis of CSLO data from CHEM-026 2015-16 and CHEM-029 2012-13 assessment of CSLO3 all covering performing laboratory analyses methods.

Part 3: Assessment Findings

What are the findings from your assessment efforts?

- Summarize and interpret your data. How many students were at each proficiency level?
- Describe what you discovered about your students and their learning from the assessment.

PSLO1

High Proficiency__55___
Meets Proficiency_12___
Below Proficiency_9___

The assessment indicated that the majority of students were at or above proficiency standards. Analysis of the data indicates that student are slightly more comfortable applying the scientific method in a quantitative approach than a qualitative approach- approximately 74%, 16%, and 11% of students showed high, at, and below proficiency with quantitative analysis respectively as opposed to 71%, 16%, and 13% respectively with qualitative analysis.

PSLO2

High Proficiency__9___
Meets Proficiency_8___
Below Proficiency_11___

The assessment indicated that a slight majority of students met proficiency standards. Further analysis of the data showed that most students understand the quantum mechanical model (High Proficiency: 16, Meets Proficiency: 7, Below Proficiency: 5), but had difficulty applying the model solve problems dealing with to atomic structure (High Proficiency: 3, Meets Proficiency: 14, Below Proficiency: 11) or the periodic table (High Proficiency: 9, Meets Proficiency: 8, Below Proficiency: 11).

PSLO3

High Proficiency__51___
Meets Proficiency__11__
Below Proficiency__16__

Stoichiometric calculations are one of the most integral topics in a chemistry program. These results are not unusual for our classes, but of course we would prefer them to improve. The distribution of proficiencies was better for the Chem 28 course than the Chem 25 suggesting student are improving in this area as they progress though the program.

PSLO4

High Proficiency__6___
Meets Proficiency__13__
Below Proficiency__15__

The assessment data has revealed an area of student learning that needs attention. Driven by these assessment results, the instructor made significant changes in pedagogy. New assessment data indicates that these changes, including the change from 3 exams to 4 exams during the semester, has helped students become more proficient in predicting the products of organic chemical reactions.

PSLO5

High Proficiency__6___
Meets Proficiency_17___
Below Proficiency_2___

The assessment indicated that the majority of students were at or above proficiency standards. Analysis of the data indicates that student are much more proficient with questions and labs related to kinetics (kinetics research project: 18 high and 6 meet proficiency and exam questions combining kinetics and thermodynamics: 12 high and 13 meet proficiency) than questions applying the laws of thermodynamics (6 high and 12 meet proficiency).

PSLO6

High Proficiency___19_
Meets Proficiency__11__
Below Proficiency__4__

NMR Spectroscopy is an essential topic of Organic Chemistry (Chem 28 and Chem 29), and these assessment results indicate that most students are proficient or better in this area. However, given the emphasis of this topic and the considerable amount of class time devoted to it, it is troubling that 4 students struggle with NMR Spectroscopy. Furthermore, the data implies that more students might not be proficient in the less-emphasized topics encompassed by PSLO4, and teaching strategies should be directed at improving student learning in this PSLO.

PSLO7
High Proficiency___28_
Meets Proficiency__21__
Below Proficiency__9___

The assessment indicated that the majority of students were at or above proficiency standards. Analysis of the data from CHEM-026 indicates that students are much more proficient at preforming the laboratory analysis (16 high and 7 meet proficiency) than analyzing data (2 high and 11 meet proficiency).

Part 4: Next Steps

What are your next steps?

- How will the results of this assessment be used to improve student learning in your program, if you found that improvement is needed? How might you adjust your teaching methods, program design, or other component of your program, if applicable?
- To what extent do your results point you to a need for professional development? Explain.
- What is the plan of action and timeline of your next steps? Who are the major players?

PSLO1
The scientific methodology and its explicit steps are covered in all fields of science. Students exposure to and practice applying the scientific method in a variety of courses and situations has shown to be successful in this analysis as the majority of students are above or at proficiency. We plan to continue to emphasize this methodology throughout the chemistry courses and laboratory experiments paying particular attention to qualitative analysis.

PSLO2
The quantum mechanical model is an abstract and difficult concept to grasp. Hopefully providing animations and videos will help students apply the material, additionally a virtual lab simulation will be explored to give students more exposure to models of the atom including the quantum mechanical model. We will emphasize applying the quantum mechanical model in in-class discussions by asking student to explain why particular trends are observed.

PSLO3
We will introduce more outside of class opportunities for students to practice predicting and balancing chemical equations, dimensional analysis, and stoichiometry. Specifically online quizzes will be implemented in hopes of increasing the frequency of practice.

This course was the first time the instructor of the student population attempted an atom first approach to the material, which resulted in postponing covering these vital topics in detail until the third unit. We will approach the course material in a more traditional format, giving us the opportunity to reinforce the concepts throughout the semester.

A pre-semester workshop has also been established and has been conducted for several semesters since this assessment was preformed. The workshop covers several topics such as predicting and balancing equations and stoichiometry at an introductory level in hopes of preparing students for a more advanced look at these topics in their chemistry courses at LMC.

PSLO4
Assessment results were very informative, and empowered by this knowledge, the instructor initiated several pedagogical changes that are producing improvements in this PSLO. Most helpful to students has been separating the content into more manageable sections by increasing the number of exams during the semester from 3 to 4.

PSLO5
We plan to allocate more time at the beginning of the unit covering thermodynamics on uncovering the skills and understanding students already have related to this topic from previous courses. Hopefully, helping students integrate what they already know about thermodynamic with new topics will increase proficiency.

With the success of the pre-semester workshop for CHEM-025, we would like to establish and offer a similar workshop for the second semester of chemistry should funding become available.

PSLO6
Although the assessment results indicate that most students are proficient in this PSLO (spectroscopy, how light interacts with matter), we plan to make minor changes to improve student learning. As we incorporate changes with success in other PSLOs, we plan to adapt those successful changes in this PSLO also.

PSLO7
We are working to incorporate more student-driven research experiences consistently and throughout the chemistry curriculum in hopes that opportunities to conduct research will improve data analysis skills.

Part 5: Report Summary

What we wanted to learn about our students:
As we strive to achieve the Chemistry Department's goal to prepare students for successful science-related careers, we want to learn the following about our students:

1) To what extent are our graduates prepared for the work needed at a transfer institution to complete their degree in Communication?
2) What can we do to improve program effectiveness and/or student learning in the department?

Specifically we want to improve transfer/completion rates and evaluate what is working or not working well in our instructional/program design.

What we did:
We collected assessment data from thoughtfully chosen sources including exams and lab projects, and we analyzed them to measure student proficiencies in the major content and skill areas of chemistry as outlined in our PSLOs. The data spanned several academic years and several different courses to reveal an overall picture of how well students learn chemistry in our program.

What we learned:
Overall students are learning a lot of chemistry! LMC Chemistry students can successfully apply the Scientific Method to solve a variety of problems. They can carry out complex chemical calculations (stoichiometry) that are used to analyze and predict chemical reactions, and our students are skillful in the laboratory completing intricate and advanced laboratory projects that involve chemical topics as such kinetics or NMR Spectroscopy. Our assessment results also revealed areas to refocus our teaching efforts. We are making some improvements to our classroom and laboratory activities, and already we see evidence that students are benefitting through more engagement and better test scores.

What we plan to do next to improve student learning:
We plan to build off the strengths of the Chemistry Program and add improvements to make it better. LMC students employ the Scientific Method successful, so we are providing more opportunities and emphasis to use it in more challenging situations, such as qualitative analysis. We will introduce more outside of class opportunities for students to practice predicting and balancing chemical equations, dimensional analysis, and stoichiometry. Specifically, online quizzes will be implemented in hopes of increasing the frequency of practice. In the chemical laboratory, we are working to incorporate more student-driven research experiences consistently and throughout the chemistry curriculum in hopes that opportunities to conduct research will improve data analysis skills. Furthermore, a pre-semester workshop has also been established that covers several chemistry topics at an introductory level in hopes of preparing students for a more advanced look at these topics in their chemistry courses at LMC. With the success of the pre-semester workshop for CHEM-025, we are planning to offer similar workshops for other chemistry courses to provide more support for our students.