Annual Report for Assessment of Outcomes -- CH

(For Degree, Certificate or Core Outcomes)

To complete this Assessment Report, please address the questions below, and send to *learningassessment@pcc.edu* **by June 20, 2011;** subject line: REPORT Assessment [SAC]

1. Describe changes that have been implemented towards improving students' attainment of outcomes that resulted from outcome assessments carried out in the previous academic year.

   (Information provided here may be referenced, inserted into or summarized in Program Review 2.C.iii (for Core Outcomes) or 6.B.iii (for CTE Degree and Certificate outcomes).

First and foremost, we learned that we need to plan out these assessments on a district wide level and completed this year's assessment in this manner.

Second, we implemented the changes we suggested as a result of our assessment of critical thinking last year. The changes are three-fold and involve our Organic Chemistry series CH 241-3, Chemistry courses that use the clicker response system during lecture and CH 104 at Cascade.

Organic Chemistry Series CH 241-3:

Last year we determined that in order to assess if students are learning critical thinking skills as a result of taking organic chemistry, a baseline analysis of student work was needed. We therefore applied the rubric we created last year for the literature research project in CH 243 to the same project in CH241. We look forward to analyzing the data collected from both classes to accurately measure if the students are improving in the application of their critical thinking skills for a research project. The analysis has not happened as the data from CH 243 was collected at the end of spring quarter. In addition, instructors provided additional guidance throughout the year about how to identify the organic chemistry problem or question for their projects to help improve these critical thinking skills.

Chemistry Courses using the Clicker Response System:

Instructors changed some clicker questions asked during lecture to reflect that we should consider the students' assumed background knowledge, wording of the conceptual questions, and choice of common incorrect answers. In addition, to get a more accurate picture of critical thinking processes, students have been periodically asked to explain their reasoning after answering a clicker question.

CH 104:

The 10 labs that are completed at Cascade during CH 104 were analyzed and changes were made to some of the analysis questions at the end of the labs that students must complete. These changes involved retooling the questions to focus more on engaging students in critical thinking about the data they collected and the conclusions they are able to make. As most CH 104 classes run in the fall, we look forward to assessing whether or not our changes helped our students attain the critical thinking

outcome for the CH 104 course. This can be assessed using the rubric we developed for the original data collection.

The 10 CH 100 labs that are completed at Cascade will be rewritten or retooled this summer. The same types of changes and focus on engaging students in critical thinking will be made to these labs. These labs will also be used at the SE Center when Chemistry is delivered there for the first time this coming fall.

2. Identify the outcomes assessed this year, and describe the methods used.
   What were the results of the assessment (i.e., what did you learn about how well students are meeting the outcomes)?
   (Information provided here may be referenced, inserted into or summarized in Program Review 2.C.i& ii (for Core Outcomes) or 6.B.i & ii (for CTE Degree and Certificate outcomes)

   a. Describe the method(s) you used.

The Chemistry SAC chose Communication and Culture for their assessment this year.

Culture
The chemistry SAC determined that we do not specifically address this college core outcome in our courses and therefore do not need to assess this outcome for attainment.

NOTE: We do require students to engage in a large amount of group work, which requires students to be culturally aware. However, we do not assess that students are achieving this outcome. In addition, the international nature of the chemistry discipline is mentioned and discussed in most chemistry courses.

Communication
Students in all Chemistry courses across the district complete a weekly lab. After they complete these labs we ask the students to analyze their data, critically think about the data, make conclusions based on their data and then communicate these thoughts and conclusions to us in the form of a lab report. We consider communication of these thoughts and conclusions through a written lab report to be a basic skill that our students at all levels of chemistry must learn. We assess how well the students are achieving this basic skill by grading these lab reports and giving the students feedback on how well they are doing.

Therefore, our assessment goal was as follows: Can students effectively communicate in writing their critical thinking skills by analyzing their own or class data to reach a valid conclusion?

To achieve this goal all the full-time Chemistry SAC members created, discussed, and approved a Written Communication Rubric (See Appendix 1) to analyze lab reports at all levels of chemistry at PCC. Then the instructors collected lab reports twice during the winter quarter from ten random

students in CH 105, CH 222 and CH 242 at each campus. One set of lab reports were collected at the beginning of the term and the second reports were collected near the end of the same term to allow for assessment of the writing progress that students were making during the quarter in each class. The instructors photocopied only the data analysis sections (Discussion/Conclusion or Claim/Evidence sections, depending on the campus) from each lab report to apply and normalize the rubric with other faculty members. Ideally, the collection of 20 reports (10 early and 10 late) for each course at each campus would have resulted in 60 total reports to assess for each course during the spring in-service. However, due to time constraints at in-service this number was reduced to 10 reports (5 early and 5 late) for each course at each campus. This collection resulted in 30 total labs to assess for each of the three courses, 10 from each campus. (Note: Since Cascade does not offer CH 242, only 20 total labs were analyzed for this course).

During the spring 2011 SAC in-service day the faculty split into 3 groups (CH 105, CH 222 and CH 242) and applied the rubric to the 30 labs from each course. The scores for each lab report were entered into a score sheet (See Appendix 2). To ensure consist scoring using the rubric each group completed the following normalization process. Each instructor identified early and late lab reports for 5 students and attempted to identify the worst reports from a student who passed the course, the best lab reports from a second student and three random sets of reports from the remaining students. The members of each group applied the rubric to a single lab report and decided how to score the report as a group with much discussion. This process was repeated for an additional report. Then to ensure consistent scoring each group member individually applied the rubric to another report and then shared their results to see if each had scored the same report identically. This process was repeated with another lab. After the faculty obtained consistent scoring of the rubric the normalization process was complete. The remaining lab reports were then split amongst the members and scored on an individual basis.

The final scores from the group and individual analysis of the lab reports were compiled and analyzed. The rubric scores were compared both between labs completed early in the term and later in the term for individual courses and between the three levels of chemistry.

b. Results: What did you learn?

For each sub-category outlined in the Chemistry SAC-developed Scoresheet (Appendix 2) the average values were calculated for the analyzed early set of lab reports and the late set of lab reports for each course (CH105, 222, and 242). The results of this faculty analysis are summarized in Table 1 with the corresponding rating system provided below the table.

Table 1 Communication Average Rubric Results for Lab Reports by Course

Course/ Rubric Category	Avg 105 Early	Avg 105 Late	Avg 222 Early	Avg 222 Late	Avg 242 Early	Avg 242 Late
Mechanics	2.33	2.67	2.97	3.20	2.40	2.90
Organization	2.33	2.78	2.90	3.10	2.30	3.10
Claim/ Conclusion	2.44	2.56	2.63	3.13	2.80	3.20
- presentation of data	1.67	2.33	2.87	2.80	2.80	3.20
- data reference	2.00	2.56	2.60	2.70	2.60	3.10
- assumptions	1.22	1.44	NA	NA	1.80	2.40
- argument	2.22	1.89	2.93	2.93	2.40	2.70
- error analysis	1.00	1.44	2.75	2.83	2.00	2.90
Theoretical Explanation	1.33	1.67	2.79	2.11	1.70	2.70
Reflection	1.00	1.44	3.70	4.00	NA	NA
Overall Averages	**1.76**	**2.08**	**2.90**	**2.98**	**2.31**	**2.91**

Ratings	Beginning	Developing	Accomplished	Exemplary
	1	**2**	**3**	**4**

Overall, every course evaluated resulted in some communication improvement from the early lab report of the term to the last lab report of the same term in several subcategories. Specifically, every course improved in Mechanics, Organization, Claim/Conclusion, *Data Reference*, and *Error Analysis* as shown in Table 1. These are very important skills for any science student to develop in their early college education, due to the fact that written communication is one of the most important methods for scientists to share new experimental results. Therefore, in an attempt to improve these very critical written communication skills, every chemistry course across the district requires students to write almost-weekly lab reports throughout each term. The overall expected improvement is also evident by comparing the early and late lab report Overall Average values for each course, where CH105, 222, and 242 improved from 1.76 to 2.08, 2.90 to 2.98, and 2.31 to 2.91, respectively. This clearly indicates that on average students enrolled in these courses did improve in their overall written communication skills.

Despite these many improvements, there were several unexpected results of this analysis. First, the CH222 lab reports showed decreased average values for the *presentation of data* (2.87 early to 2.80 late) and for the *theoretical explanation* (2.79 early to 2.11 late) subcategories and CH105 showed a decrease for the *argument* (2.22 to 1.89) subcategory. There are a few reasons why these decreases may have occurred. 1.) These decreases may be statistically insignificant due to the small sample size analyzed, especially for the CH222 *presentation of data*. 2.) The lab concepts addressed at the end of the term may be significantly more difficult for a student to accurately communicate compared to the concepts addressed at the beginning of the term, which would affect a student's *theoretical explanation* or *argument.* 3.) Faculty may have encountered inconsistencies or difficulties with applying the rubric as currently written. For example, the *theoretical explanation* subcategory on the rubric requires a particle-level explanation for a student to achieve a rating of 3, corresponding to Accomplished, but some lab report instructions do not specifically require students to provide particle-level explanations. The overall suggested improvements to the rubric will be addressed in more detail in the next section.

In addition, the average late values obtained for some of the sub-categories—*assumptions*, *error analysis*, and Theoretical Explanation—are less than desired. For example, the average *error analysis* values for Late CH105, 222, and 242 are 1.44, 2.83, and 2.90, respectively. Although each of these values improved from the beginning of the term, students completing the second term of Organic Chemistry should achieve at least an average of 3 to indicate that students identify and thoroughly explain possible sources of experimental error by the end of their second term of the second year chemistry course. It was surprising to see that the *assumptions* values were the lowest scores obtained by CH105 and CH242 students. Possible reasons for the low values for this subcategory are identified below.

Another unexpected result revealed by the Communication Rubric analysis is the absence of particular subcategories for two of the courses. Specifically, the CH222 a*ssumptions* and the CH243 Reflections received NA (not applicable) scores to all of their lab reports. The possible reasons for these absences include the absence of a reflection section in the lab report instructions given to students and the vagueness in the rubric for defining *assumptions*. If a clear definition for the required assumptions could not be achieved by the three faculty members analyzing the lab reports, then an agreement was made to give an NA rather than to give non-calibrated values for each report. In addition, depending on the experiment completed by the students, particular assumptions may not have been required for the final lab report.

The chemistry program also expects to see improvement in written communication as a student moves through the entire program from CH100 to the CH221 series to the CH241 series. Although data was not collected for these three courses, it is interesting to note that the average CH105 late values are lower than the corresponding late CH222 and CH242 values for every Rubric Category. This should be expected, since the students enrolled in CH222 and CH242 are completing degrees for science, engineering, pharmacy and some health-related fields, whereas, students enrolled in CH105 are more likely to complete nursing degrees. Therefore, more extensive lab reports are required for the CH221 and CH241 series compared to the CH104 series. However, a similar trend should be observed when comparing the late CH222 results to the late CH242 results. Although improvements are observed for

Claim/Conclusion, *presentation of data*, *data reference*, *error analysis*, and Theoretical Explanation, the overall averages indicate a decrease from 2.98 for CH222 to 2.91 for CH242. This decrease is somewhat surprising, because CH242 students are expected to have overall better communication skills, since these students completed a full year of general chemistry prior to CH241. There are a few possible explanations for this unexpected trend. 1.) The decrease may be statistically insignificant due to the small sample sizes. 2.) The prerequisite for the CH241 series states successful completion of the CH104 series OR the CH221 series, so students in CH242 may have completed the less rigorous CH104 series, which could result in lower communication scores in CH242. 3.) Some students in CH242 have 3 or more years between their completion of a general chemistry series and the organic chemistry series. This time lapse between courses could result in a decrease of communication scores for *argument* and *theoretical explanation*—the two subcategories with the largest decrease from Last CH222 to CH242—due to a less thorough understanding of the concepts investigated. Overall, it is difficult from the acquired data set to make definite conclusions about the overall chemistry program's effectiveness in teaching communication skills from CH100 to the CH221 series to the CH241 series. However, the current data clearly indicates that students in CH222 and CH242 have more effective written communication skills compared to the students in CH105.

3. Identify any changes that should, as a result of this assessment, be implemented towards improving students' attainment of outcomes.

(Information provided here may be referenced, inserted into or summarized in Program Review 2.C.iii (for Core Outcomes) or 6.B.iii (for CTE Degree and Certificate outcomes)

The following proposed changes are in process to obtain Chemistry SAC approval. Due to the Learning Assessment Council's current time schedule for assessment, the Chemistry SAC did not have an opportunity to discuss the assessment results before the summer break. Therefore, the following recommendations will not be discussed by the Chemistry SAC until the Fall In-service in October.

1.) *Modify the Written Communication Rubric to clarify specific subcategories.* The communication rubric was developed with the knowledge that each campus completes a different set of experiments with different lab report requirements. The Chemistry SAC prides itself for allowing instructor flexibility when choosing particular experiments to investigate specific concepts. Therefore, the SAC attempted to create a generic rubric that could be applied to any chemistry lab report. When the faculty actually utilized the rubric, some problems with the rubric were clearly evident. Specifically, the *assumptions* category was very vague and resulted in NA scores for the CH222 lab reports. The CH242 instructors defined this category as a written balanced equation and detailed mechanism with explanations. This will not be the same description required for CH105 or CH242. The Theoretical Explanation category also needs clarification, especially for the particle level explanations that currently do not exist in many lab reports across the district. The importance of the Reflection section on this rubric also needs to be discussed, since CH242 entered NA scores. The personal pronoun usage in the Mechanics section also needs to be discussed by the SAC for more flexibility in scores or to revise our lab report instructions to indicate this requirement to our students.

2.) *Clearly outline the lab report collection procedure.* Three problems existed for the actual lab collection. First, some faculty only photocopied the data analysis/conclusion sections, which may have omitted some of the written communication sections that students provided previously in the report. Second, when the faculty gathered to analyze the reports, it was evident that the reports should have been numbered according to the student work. It was very challenging to identify the early and late reports for the same student, since the names had to be removed. This can be resolved if each faculty member assigns each student a number for the term, so that an early and late lab report can easily be identified. Finally, some faculty collected the reports for the very first lab session of the term that focused on Safety rather than on new concepts. The chosen early labs need to clearly be an investigation of a new concept that can be thoroughly discussed in the lab report.

3.) *Obtain larger sample sizes.* As explained previously, the initial sample size was reduced in half due to time constraints, which may result in larger error bars in our analysis. The Chemistry SAC will need additional resources in order to collect more data, including additional SAC in-service days to complete data analysis, more funding and time to photocopy all these lab reports, and more pay for part-time faculty to participate in this process.

4.) *Modify instructions in the current lab reports to clarify the communication requirements for the students.* Some categories for the communication scores were very low or difficult to assign to some lab reports, because the lab instructions were not specific enough to include particular items that were scored. Specifically, the current CH242 lab reports do not require a reflection statement that links the concept/theory under investigation to the real world. If this is expected by the CH242 students, then a revised reflection section needs to be included. In addition, the Theoretical Explanation requires particle-level explanations for observed data. Students will not do this unless instructed to do so in the lab report. The Mechanics section also needs be clarified in the lab report instructions. If students should not use the first person in the discussion/conclusion or claim/evidence sections, then the students need to see this in the lab instructions. Some students may have received lower communication scores, just because they didn't know the writing expectations.

5.) *Provide a copy of the rubric to the students at the beginning of the term.* When the students obtain a copy of a rubric, they will clearly know the expectations for an exemplary lab report in terms of good written communication skills. The instructors for each course across the district should decide on the desired scores that a student should achieve at the end of the course to inform the students what the target score should be for their class. For example, a CH100 student would not be expected to reach the Exemplary level, because this is an introductory chemistry course. However, a student completing the CH243 course should reach the exemplary level by the end of the term.

6.) *Incorporate more peer-review opportunities for the students.* Peer reviews provide an excellent opportunity for students to improve their lab reports. Instructors can provide the faculty-modified rubric to their students to complete a peer-review evaluation of an early lab report during a scheduled lab session. Not only will the students gain invaluable feedback, this will

also provide students with very clear expectations for the lab reports. One limitation to this process is the lack of time allowed in already-packed 3-hour lab sessions. The chemistry faculty will need to brainstorm ideas for how to incorporate peer-review opportunities in each course.

7.) *Include CH100 lab reports for a more thorough study of the program.* In our initial plan three instructors were identified to collect these reports. However, due to illnesses, communication errors with part-time faculty, and time constraints, these reports were not included in the current analysis. The inclusion of CH100 would allow for a more thorough study of the chemistry program, because this course currently serves as a preparatory course for the CH221 series and a non-science majors science credit. Many students who complete CH100 subsequently enroll in CH221. A small fraction of students who successfully complete CH223 then enroll in CH241. Although the current investigation included CH105, many of these students do NOT enroll in CH241. The CH100 reports will allow for a more thorough analysis of the progression of communication skills students learn through our program.

8.) *Include CH104, CH106, CH221, CH223, CH241 and CH243 lab reports for a more thorough study of the chemistry program.* In addition to the CH100 lab reports described in recommendation #4, the inclusion of the beginning (104, 221, and 241) and ending (106, 223, and 243) courses for our year-long series will really allow for a very thorough study of how our courses improve written communication skills for our students. However, the Chemistry SAC encounters several difficulties with making these additions: 1.) The current Learning Assessment Council Schedule does not allow time for the chemistry SAC to begin data collection in the fall term, since the plans are submitted in October. In addition, this same schedule does not allow the faculty to collect and analyze data from the spring term, since the reports are due by mid-June—only one week between final exams and the final assessment due date. 2.) Full-time faculty require release time to apply rubrics to the large number of courses required to fully assess. Extra time is required to collect and file permission slips, photocopy early and late lab reports for a large enough sample size, and it takes approximately 8 minutes/lab report to accurately apply the rubric. Additional time is required to meet for normalization, compile the data, and finally to provide a thorough analysis. 3.) Additional financial support is required for part-time faculty. Since a very large number of our courses are taught by part-time faculty, we need to include additional funding to ensure that courses at all levels of our program can be adequately analyzed for the communication rubric.

9.) *Prepare one rubric for ALL the Learning Outcomes—Critical Thinking, Communication, Professional Competence, Self Reflection, and Community and Environmental Responsibility.* Since a large amount of time is spent collecting permission slips, photocopying lab reports, meeting for normalization, applying the rubric, and analyzing the results, much time could be saved by creating one rubric that addresses all the Core Outcomes. This would save a significant amount of time for the faculty if one rubric was created and applied to one set of assignments. If a set of early and corresponding late lab reports were collected and photocopied for CH100, CH104, CH106, CH221, CH223, CH241, and CH243, then we would

have a very thorough picture of the effectiveness of our program and where we could improve. The SAC recognizes that this is a very long-term goal that cannot be completed until the current process has stabilized and the SAC recognizes the specific types of data required for each learning outcome.

In summary, the Chemistry SAC created and applied a Written Communication Rubric for CH105, CH222, and CH242 courses across the district. The results of applying this rubric to early and late lab reports for each class revealed that these courses clearly showed overall improvement in written communication. The areas that did not show improvement can be attributed to small sample sizes, vague rubric guidelines, unclear instructions given by the instructor, or more difficulty in the concepts addressed at the end of the term compared to the beginning of each term. To improve the review of the Communication Core Outcome nine suggestions were proposed that need to be approved by the entire Chemistry SAC at the fall in-service in October. Recommendations #1, 2, 4, 5, and 6 can be made fairly easily for the next time the Communication Rubric needs to be applied. However, Recommendations #3, 7, 8, and, 9 will require many additional resources as specified in each description. The Chemistry SAC will continue to make improvements to all the courses, especially to inform the students about the writing expectations for each course, to ensure that students continue to improve their written communication skills.

Appendix 1 Chemistry Written Communication Rubric

	Beginning	Developing	Accomplished	Exemplary
	1	2	3	4
Mechanics	Terminology often used incorrectly; many grammatical, spelling and punctuation errors; irrelevant information included often; personal pronouns used.	Terminology sometimes used incorrectly; several grammatical, spelling and punctuation errors; irrelevant information included; personal pronouns used.	Incorrect terminology used rarely; few grammatical, spelling and punctuation errors; irrelevant information included; no personal pronouns used.	Proper terminology used; proper grammar, spelling, punctuation; good sentence and paragraph structure; Concise (relevent info included, extraneous info excluded); no personal pronouns used.
Organization	Disorganized to the extent that the point of the argument is lost.	Somewhat logical progression of the argument,; the logic may be hard to follow.	Mostly logical progression of the argument, with some minor exceptions.	Overall logical progression for presenting the argument.
Claim/ Conclusion	No claim or conclusion is apparent, or claim/conclusion is not related to the experimental problem or is incorrect.	Claim/conclusion is made, but is not clearly separated from the evidence/analysis (evidence is included in the claim statement, or not explicity stated at the end of data analysis).	Claim/conclusion is generally correct, though may not be stated as concisely as possible.	Claim/conclusion is accurate and logically follows from data analysis. It is succinct, clear, relevant/valid, and consists of only 1-2 sentences. No subjective statements.
Evidence/ Analysis				
- presentation of data	Drawings, diagrams, graphs, tables are missing or do not support claim/conclusion.	Drawings, diagrams, graphs, tables are used but do not support claim/conclusion and are significantly incomplete.	Drawings, diagrams, graphs, tables are properly used to support claim/conclusion but are significantly incomplete.	Proper use of drawings, diagrams, graphs, tables to support claim/conclusion; labeled, clear, relevent info presented, extraneous info excluded, proper sig figs and units.
- data reference	Raw data is not referenced at all.	Raw data is mentioned but not referenced by page/table number and is not summarized.	Raw data is referenced by page/table number and summarized, but not accurately or completely.	Reference to raw data - what data was collected, how were measurements made, which variables were controlled.

- *assumptions*	Not stated.	Stated, but incomplete, unclear, or incorrect.	Stated but incomplete. Those stated are relevent/valid.	Clearly stated; relevant/valid.
- *argument*	Missing or faulty analysis of the data leading to a conclusion. Use of general statements or opinions without data to support it.	Incomplete or slightly faulty logical analysis of the data leading to a valid conclusion. Use of general statements or opinions without data to support it.	Mostly correct and logical analysis of the data leading to a valid conclusion.	Correct and logical analysis of the data leading to a valid conclusion.
- *error analysis*	No mention of accuracy or precision of data; lack of reflection on experimental techniques and procedures and potential sources of uncertainty; lack of reflection on personal lab skills and unexpected experimental events.	Reliability of data mentioned; inadequate or faulty supporting statements regarding accuracy or precision of data; inadequate or faulty reflection on experimental techniques and procedures and potential sources of uncertainty; inadequate or faulty reflection on personal lab skills and unexpected experimental events.	Reliability of data mentioned; partial use of calculations/graphs to support statements regarding accuracy or precision of data; partial reflection on experimental techniques and procedures and potential sources of uncertainty; partial reflection on personal lab skills and unexpected experimental events.	Concise statement of reliability of data; use of calculations/graphs to support statements regarding accuracy or precision of data; thoughtful reflection on experimental techniques and procedures and potential sources of uncertainty; reflection on personal lab skills and unexpected experimental events.
Theoretical explanation	None given, or incorrect theory given, or experimental data is given.	Some correct theory is presented, but it is not completely accurate or includes experimental data.	Theoretical explanation given, but is incomplete or focuses on mathematical relationships instead of particle level explanation.	Valid particle explanation for observed data is given.
Reflection	No reflection or completely unfactual reflection on the linkage of concept/theory to the world outside the lab.	Inadaquate or partially unfactual reflection on the linkage of concept/theory to the world outside the lab.	Partial factually based reflection on the linkage of concept/theory to the world outside the lab.	Factually based reflection on the linkage of concept/theory to the world outside the lab.

Appendix 2 Lab Report Score Sheet for Rubric

Class	

Reviewer	

Ratings	**Beginning**	**Developing**	**Accomplished**	**Exemplary**

Campus								1	2	3	4
Week Completed											
Student	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	Average
Mechanics											
Organization											
Claim/ Conclusion											
Evidence/ Analysis											
- presentation of data											
- data reference											
- assumptions											
- argument											
- error analysis											
Theoretical explanation											
Reflection											
Average											