

Annual Report for Assessment of Outcomes 2012-13

Subject Area Committee Name: _____ CHEMISTRY _____

Contact person: _____ Ted Picciotto _____

For LDC/DE: Core outcome(s) assessed: _____ Critical Thinking and Professional Competence _____

For CTE: Degree or certificate* assessed: _____ NA _____

*please attach a table showing the alignment of the degree or certificate outcomes with the College Core Outcomes

Please address the questions below and send to learningassessment@pcc.edu by **June 21, 2013** with Annual Report in the subject line

Note: Information provided in this report may be inserted into or summarized in Section 2C Program Review Outline.

1. Describe changes that have been implemented towards improving students' attainment of outcomes that resulted from recent outcome assessments. These may include but are not limited to changes to content, materials, instruction, pedagogy etc. Please be sure to **describe the connection** between the assessment results and the changes made.

The Chemistry SAC recommends the assignments used for assessing our students self-reflecting need to be consistent across the district. The results of our evaluations have shown that these assignments are helping our students improve their self-reflective skills.

As a result of assessing the environment and community core outcome, the biodiesel lab was implemented across the district last year. The overall comparison of scores before and after the laboratory activity clearly indicates a higher level of student understanding in the area of environment and community responsibility. The laboratory experiment is now a permanent part of the curriculum in most of the chemistry courses across the district.

For each outcome assessed this year:

2. Describe the assessment design (tool and processes) used. Include relevant information about:
 - The nature of the assessment (e.g., written work, project, portfolio, exam, survey, performance etc.) and if it is direct (assesses evidence mastery of outcomes) or indirect (student's perception of mastery). Please give rationale for indirect assessments (direct assessments are preferable).
 - The student sample assessed (including sample size relative to the targeted student population for the assessment activity) process and rationale for selection of the student sample. Why was this group of students and/or courses chosen?
 - Any rubrics, checklists, surveys or other tools that were used to evaluate the student work. (Please include with your report – OK to include in appendix). Where appropriate, identify benchmarks.
 - How you analyzed results, including steps taken to ensure that results are reliable (consistent from one evaluator to another).

Critical Thinking and Problem Solving

Indirect Assessment

We chose an indirect assessment in the form of a student survey that could be used across all courses in the district. In general, the indirect assessment/survey is beneficial to our study because it allows students to incorporate a metacognitive skill, that of self reflection, to their own critical thinking skills toolbox. As well, the multiple-course, cross-district survey, administered at the beginning of the term and again at the end of the term allows the faculty the opportunity to make an initial assessment of a reflective component of critical thinking skills and the development (if any) of these skills over one 10-week term.

Specifically, the Chemistry SAC designed a short 5-question survey (Appendix 1) that was administered during the class to affect a high response rate, since based on our experience, the response rates for the online surveys have been fairly low. The questions were selected based on the characteristics of critical thinking identified by Wade (1995). We were interested in assessing the student's perception of their ability to:

- define the problem (Question 1)
- examine the evidence (Question 2)
- analyze assumptions and biases (Question 3)
- consider other interpretations (Question 4)
- tolerate uncertainty ambiguity (Question 5)

This survey was specifically design to survey a larger population of students.

Direct Assessment

In the same manner, the SAC also administered a general survey of 4 questions. These questions were supposed to give an overview of how students applied some of the thinking characteristics detailed in the indirect survey. Two of the questions assessed the student's ability to define a problem and the validity of proposed arguments (questions 1 and 2). The other 2 posed more difficult scenarios in which, in addition to the components above, they assessed the ability to analyze assumptions and biases in arguments, alternative to and limitations of proposed claims (question 3 and 4).

The surveys were administered on the first and last period of the winter 2013 to students in CH 100, CH 104, and CH 221 courses. All three courses were either single term CH100 or first term only of a 3-term sequence (CH 104, CH 221). Immediately we realized one inherent weakness of the study design. Critical thinking skills take considerable time and practice to master and certainly 10 weeks would be a challenging time period to evaluate. That being said, we are able to make some generalized conclusions of our student abilities and progress.

All CH 100, CH 104, and CH 221 instructors were asked to give this survey to their students. All the incomplete surveys were disregarded. The data was entered into a score sheet only for students who had completed the initial and the final survey. This resulted in total of 150 analyzed responses. For CH 221 class there were 109 analyzed responses (about 78.4 % of students taking the course) for CH 104 class, and 49 analyzed responses (about 39 % of students taking the course). The design of the survey did not require normalization amongst the faculty members.

Professional Competence

As a means of assessing professional competence in the field of chemistry, as a SAC we decided that the use of standardized national exams, which assess student knowledge of the field, would be directly proportional to the potential for professional competence.

The ACS National Standardized Exam is a comprehensive exam that is generated by the American Chemical Society, Division of Chemical Education, Examination Institute. The Institute has been creating exams for 75 years since 1932. Exams are produced for many chemistry courses and in particular the General Chemistry and Organic Chemistry courses that are taught here at PCC. The institute collects data on the performance of students in equivalent classes across the nation at institutions of higher education, including 2-year colleges and 4-year colleges and universities. The ACS compiles results and presents national norms. The exams are completely multiple choice and an overall raw score is obtained using ScanTrons and compared to a national average.

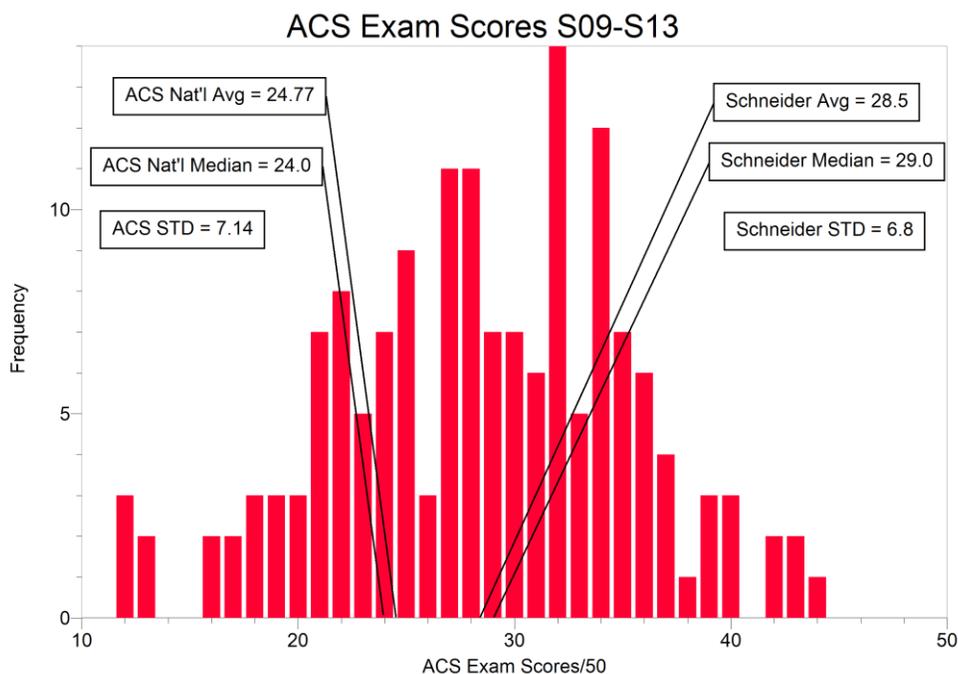
At PCC, campuses that offer General Chemistry and Organic Chemistry administer the ACS final exam at the end of the year-long course. Exam results allow the instructor to measure student's performance in the course relative to students across the nation. Data has been collected over the past few years to evaluate student outcome and performance.

Please note: The different campuses use different standardized nationally normed exams. The faculty feels that with the variety of test instrument options available from the ACS, there is thus some freedom to accommodate different teaching styles when administering these tests. However, since the ACS exams are normalized over thousands of students over many years, it is accepted that any exam will provide a reliable measure of student performance compared to similar students across the United States. Currently Rock Creek administered a cumulative 2 hour ACS General Chemistry Exam while Sylvania administers the shortened cumulative 1 hour exam. Both Rock Creek and Sylvania administer a cumulative 2 hour ACS Organic Chemistry exam at the end of the sequence.

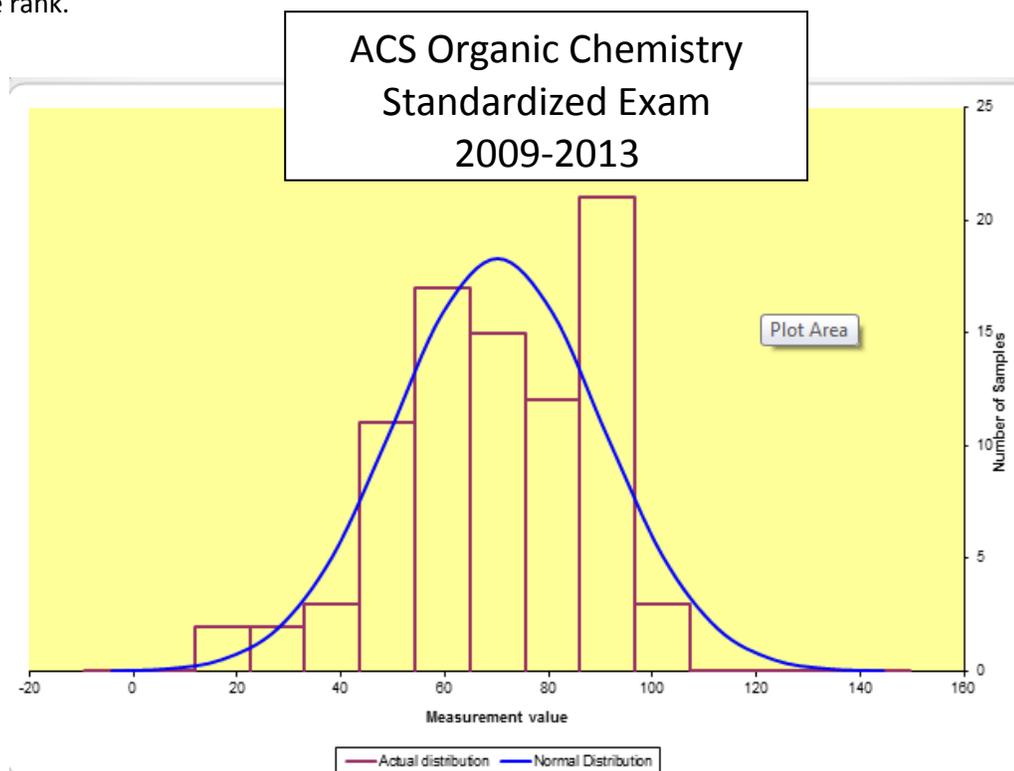
We choose the year-long ACS exams for Organic Chemistry and General Chemistry and therefore only tested our student populations at the end of the third term. The ACS also has a first semester exam for Organic and General Chemistry, but as we are on the quarter system we feel it would be difficult to implement.

Presented below, therefore, are histograms of student scores and averages as compared to the national norm for that particular exam used at that campus. Regardless of the exam, the Chemistry faculty feel that these scores provide one measure of our student's performance and accomplishment relative to a national average.

The first set of data below is a histogram showing data from the General Chemistry ACS Exam administered in the spring term by Jim Schneider for the years 2009-2013 including 159 students. As can be seen, the combined raw class average for Sylvania was 28.5/50, compared to the national average of 24.77/50 (STD = 7.1), which puts Sylvania students in the 69th percentile rank nationally, with the national mean normalized to the 50th percentile rank.



The second set of data below is a histogram showing data from the Organic Chemistry ACS Exam administered in the spring term for the years 2009-2013 by Patty Maazouz including 84 students. As can be seen, in this case we do not have the national average raw score, but in lieu of that, the percentiles. The average percentile for Sylvania was 70.1% (STD = 19.9), with the national mean normalized to the 50th percentile rank.



3. Provide information about the results (i.e., what did you learn about how well students are meeting the outcomes)?
- If scored (e.g., if a rubric or other scaled tool is used), please report the data, and relate to any appropriate benchmarks.
 - Results should be broken down in a way that is meaningful and useful for making improvements to teaching/learning. Please show those specific results.

Critical Thinking and Problem Solving

Results

The SAC notes that the current tool is severely limited in the assessment of how our chemistry classes affect the students' ability to critical thinking and problem solving core outcomes. This survey represents a small piece of that overall assessment, namely student perception of their own ability to think critically (indirect survey), and a brief snapshot of some limited critical thinking and problem solving skills (part 2 of the survey). To be sure, chemistry classes present wide and varied opportunities for students to develop these skills. This assessment presents a small part of these opportunities and was specifically designed to survey a larger population of students.

For each 5-point Likert scale question (1=Never ; 5= Always) in part 1 of the survey the average values were calculated. The results are summarized in Table 1.

Table 1: Summary of Results from the Indirect Survey

	CH 221		CH 104		CH 100	
	Initial	Final	Initial	Final	Initial	Final
Question 1	4.03	4.17	4.29	4.22	4.02	4.07
Question 2	4.16	4.33	4.20	4.38	4.13	4.06
Question 3	3.87	3.96	3.98	4.18	3.87	3.97
Question 4	3.69	4.03	3.89	4.04	3.79	4.03
Question 5	3.68	3.87	3.72	4.03	3.70	3.75
Average	3.89	4.07	4.02	4.17	3.90	3.98

The most valuable conclusion we could possibly draw from this assessment is that students come to our courses with a reasonably high confidence in their critical thinking abilities. This is reflected in high initial average scores (between 3.68 and 4.29) on the indirect assessment questions.

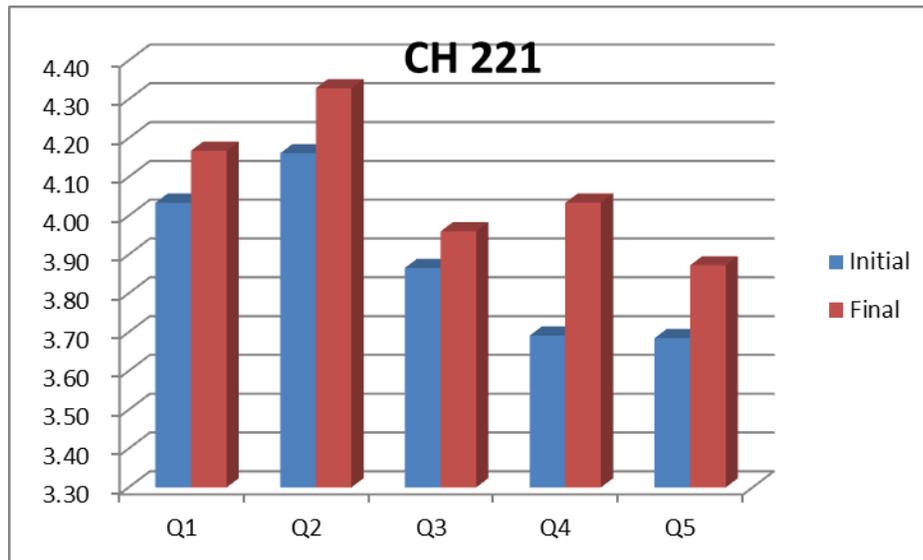


Figure 1: Initial and Final Survey Results for CH 221 Course (Part 1)

Figure 1 shows an average score of 3.89 initially on the 5-point Likert scale (1=never, 5 always). We see that post-class average is 4.07 on the same scale. A statistical analysis was not done on this data due to time constraints. It would be interesting to analyze gains or decreases in average gains to average decreases.

Regardless, Fig. 1 may indicate a perception of increased critical thinking skills for the population as a whole. As to the implications for teaching and learning we would be better served by a statistical analysis of student scores for each question to determine if perceived gains shown in Fig.1 are statistically significant. At best this data can serve to indicate generalized areas the SAC may be interested in addressing. For example, students report lower perceived abilities in considering alternative interpretations and the limitations of proposed models and concepts (question 4 and 5, part 1 of the survey). Data for CH 104 and CH 100 classes shown in Figures 2 and 3 follows similar trends.

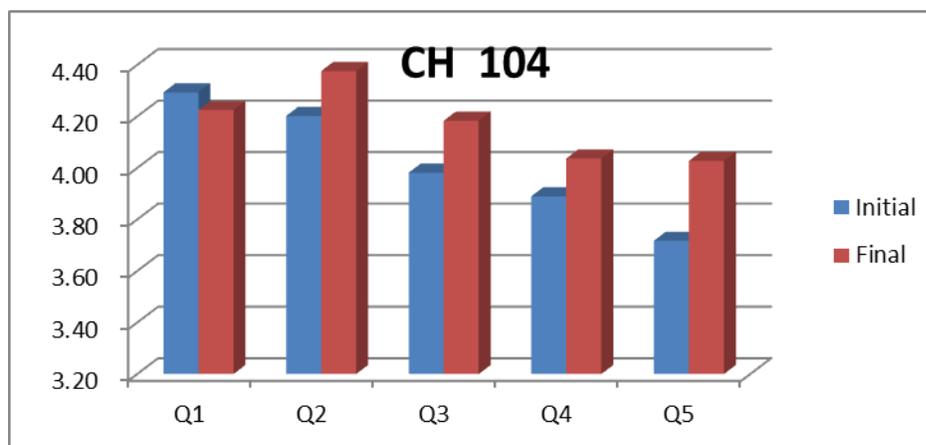


Figure 2: Initial and Final Survey Results for CH 104 Course (Part 1)

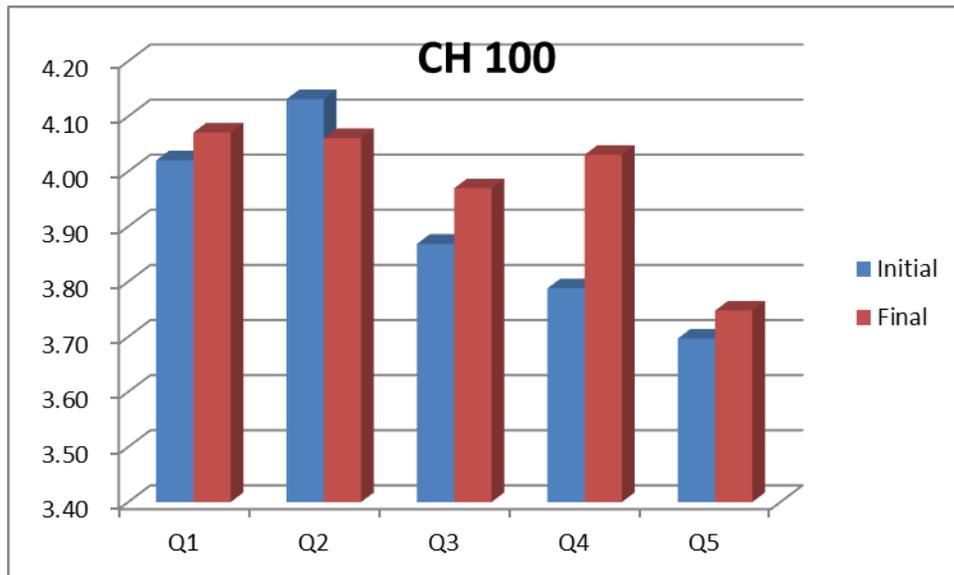


Figure 3: Figure1: Initial and Final Survey Results for Ch 221 Course (Part 1)

The direct survey (Part2) results are shown in Figure 4. The results from the CH 221 classes were less conclusive than the results from Part 1. In part this is due to the design of the assessment tool as being limited in extent.

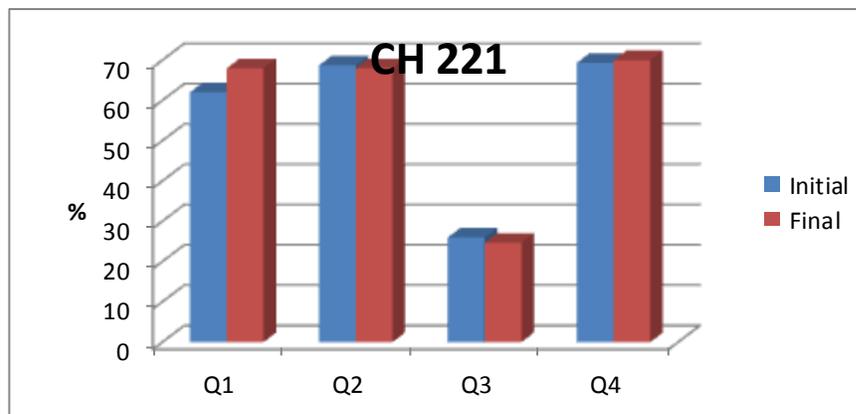


Figure 4: Shows % of students correctly answering the survey questions (Part 2)

The most outstanding data is in regard to question 3 of the survey. This is a difficult question that requires students to pay attention to the detail of the question, clearly define the question, and critically assess each claim according to both the relevance to the problem and the validity of the claim. Students in CH 221 scored only about 25% correct on average for this question, while on average students scored 68% correct on the less complex questions.

This data suggests that students have difficulty and might derail when reading scenarios (data) and thus often draw incorrect conclusions or incorrectly perceive claims as being relevant or correct. Students may have lower abilities to analyze assumptions made in claims and more limited ability to analyze evidence and how it may or may not support a claim.

The results of parts 1 and 2 seem to indicate that while students ranked their own abilities to think critically as high (Fig. 1, ave=3.9/5), their actual ability to apply perceived skills to complex problem is actually quite low. This may indicate a low skill level or ability to transfer knowledge and skills gained in one area (science classes) to everyday life. Students report gains in self-perceived critical thinking skills “In science class”, but as shown in Fig. 4 the average score on the complex problem (#3) was very low (25%) and further, no real change was noted after taking one 10-week class.

The difference between perceived gains(Part 1) and actual performance (Part2) could be interpreted that a first term chemistry class gives student exposure to and practice in critical thinking skills within the class, but very little or no practice in the transference of these skills to everyday life.

To be fair, this tool did not directly asses this conclusion, and we do feel that 10-weeks is insufficient time for significant development of these skills. However, it does provide a starting point for further study.

Similar trends were observed in data for CH 104 and CH 100 shown in Figures 5 and 6.

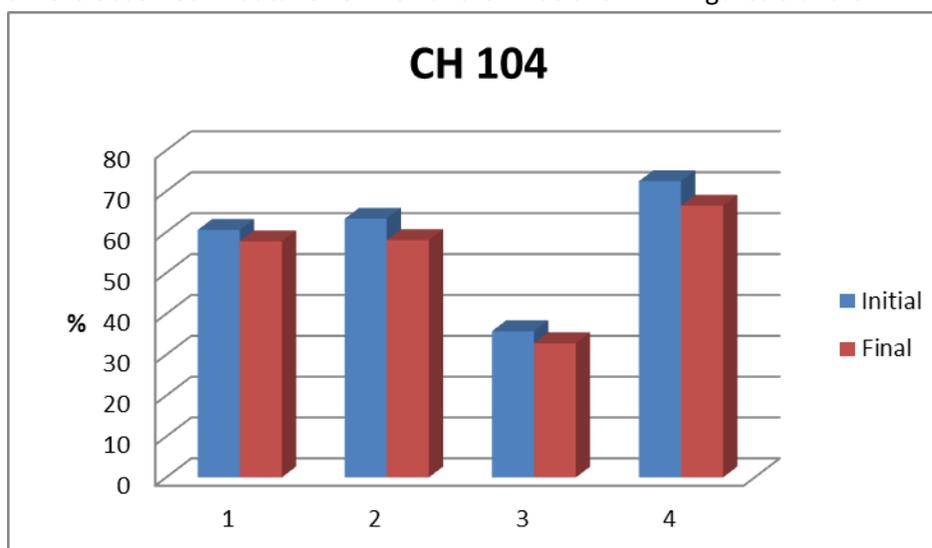


Figure 5: Shows % of students correctly answering the survey questions (Part 2)

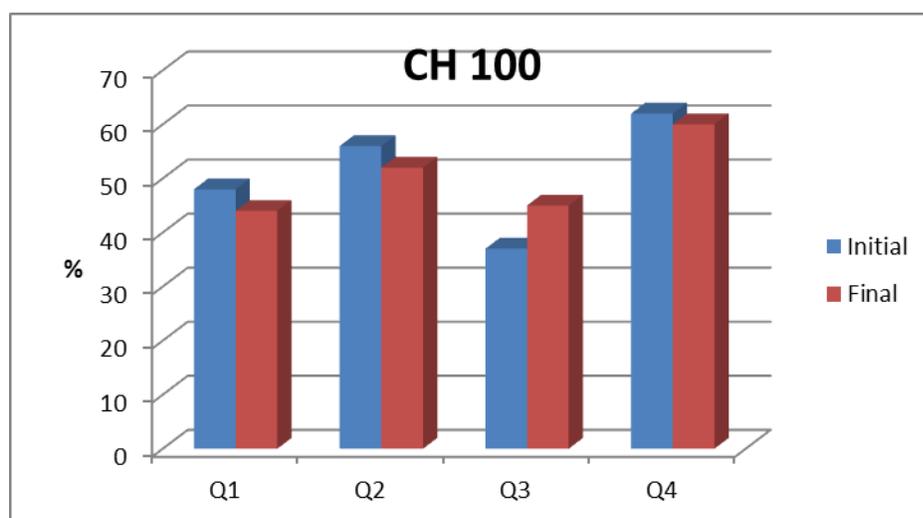


Figure 6: Shows % of students correctly answering the survey questions (Part 2)

Professional Competence

Portland Community College students at the Sylvania campus are on average 20% above the normalized average 50% percentile on both the General Chemistry and Organic Chemistry ACS exam (69% and 70% respectively). As of now, at the Sylvania campus, it appears as if we are doing an above average job. To what degree is difficult to quantify.

4. Identify any changes that should, as a result of this assessment, be implemented to help improve students' attainment of outcomes. (These may include, but are not limited to, changes in curriculum, content, materials, instruction, pedagogy etc).

Critical Thinking and Problem Solving

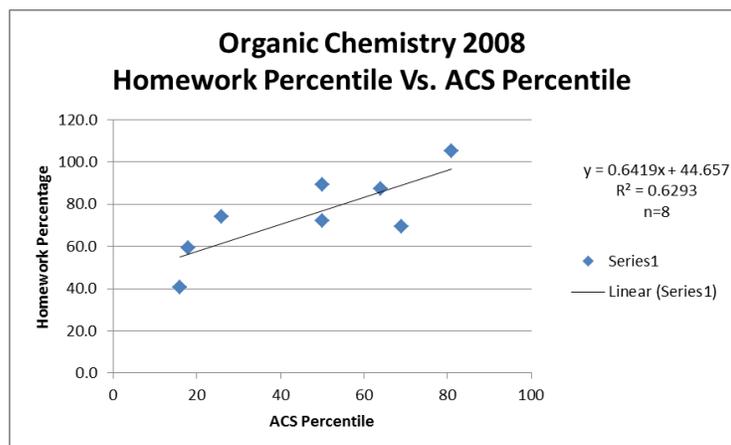
The initial assessment given its limitations, suggests weakly that further effort be made to design specific activities across the curriculum including:

- A. Since students report lower perceived abilities in considering alternative interpretations and the limitations of proposed models and concepts (question 4 and 5, part 1 of the survey) specific activities could be designed to address this issue.
- B. Much greater emphasis on transference of critical thinking skills to everyday life scenarios. For example activities including real world problems such as fluorination of Portland's water could be implemented.

Professional Competence

The initial assessment has limitations in discerning specific weaknesses in specific subject matters as well as evaluation our unique population of students as a community college. If we were able to obtain data on the community college population nationwide with respect to a median it may provide more information. The current median scores on the ACS exams are include all 4 year colleges. Additionally, if it were possible to score the exam by topic using the ScanTrons, it may help us see where our program was deficient.

For one set of ACS exam data, Patty Maazouz did compare her homework scores to the ACS Exam percentile. There was a correlation for a small data set of 8 students; however it was not very significant with an R^2 value of 0.62.



5. Reflect on the effectiveness of this assessment tool and assessment process. Please describe any changes to assessment methodology that would lead to more meaningful results if this assessment were to be repeated (or adapted to another outcome). Is there a different kind of assessment tool or process that the SAC would like to use for this outcome in the future? If the assessment tool and processes does not need to be revised, please indicate this.

Critical Thinking and Problem Solving

We do not feel the effectiveness of the tool, as originally considered was adequate. To improve, we should consider a more thoroughly designed tool that matches the assessment to core outcomes in a more direct, explicit way. As mentioned earlier, this assessment did not directly measure actual gains in areas of critical thinking as they are presented in our courses. Neither does it directly measure the transference of these skills to everyday life.

Chemistry classes are complex and by their very nature of being a core science course, deal directly with critical thinking. By many definitions thinking critically is thinking scientifically. By only accessing perceived skills in a science class we missed the actual assessment of gains of the skills we do teach, as well as the transference of these skills.

It is also evident that the core outcome of critical thinking and problem solving is incredibly complex yet incredibly important. Assessment tools covering more than one aspect of critical thinking already exist such as The California Critical Thinking Skills Test: College Level or Cornell Critical Thinking Test, Level Z. However, using such tools alone results in over testing our students. We already give our general chemistry and Organic chemistry student comprehensive full-year standardized exams written by the Exam Institute of the American Chemical Society. It doesn't seem feasible to fit additional standardized exams into our courses unless the service is provided by the testing center which has already denied us the opportunity to place our students via diagnostic chemistry exam prior to enrolling in general chemistry due to funding.

The Chemistry SAC already feels confident in the many and varied tools we currently use (concept test, thinker buddy, clicker questions, lab reports and many others) to give us feedback on students critical thinking skills. But, as this current survey would seem to indicate we need a better tool that assesses our ability to provide students the opportunity and practice to apply the transference of these skills to everyday life, as well as the assessment of improvements to these skills by students as a result of these practices.

Professional Competence

Raw scores for the ACS Organic Chemistry Exam were obtained from Rock Creek campus, however national averages were not provided so the percentile could not be judged. Raw scores were obtained for the General Chemistry ACS exam from Cascade campus and again, the specific exam used was not specified and a national average for that particular exam was not provided. Therefore it was difficult to quantify data from Rock Creek and Cascade campuses.

We need to discuss as a SAC how to centralize the data in order to more effectively analyze it in a timely fashion. One proposal is to work with Institutional Effectiveness to develop a centralized MS Excel

spreadsheet or other tool so instructors are prompted to input complete data. We may be able to develop a simple spreadsheet ourselves which would also prompt complete entry of data and graph the data as well.

I would re-iterate at this point that being able to analyze the exams by topic would be an improvement. We clearly are meeting the national standards but it is difficult to determine where the students are deficient and if they can be improved. Community college students tend to have busy lives. If there is a reasonable correlation with homework and the scores could we improve their time management to assist in homework completion? If there isn't a strong correlation between homework percentages and the exam scores, should we evaluate the manner in which homework is assigned? Would it make a difference?

There are also standardized exams for General Chemistry for non-science majors which are equivalent to our Allied Health sequence at PCC (CH104, 105, 106). We may want to consider implementing these as well to evaluate the knowledge of our Allied Health students upon completion of the second term which would be roughly equivalent to the first semester.

Appendix 1

Initial and Final Survey for Chemistry Class on Critical Thinking

Part 1

Directions: In light of your current level of educational experience of today, please answer the following questions as accurately as possible using the scale provided.

Never	Rarely	Sometimes	Frequently	Always
A	B	C	D	E

In science class:

1. I define problems clearly in my class assignments (homework, tests, quizzes, class work).

Never	Rarely	Sometimes	Frequently	Always
A	B	C	D	E

2. I carefully examine all the evidence before making an evaluation of a question.

Never	Rarely	Sometimes	Frequently	Always
A	B	C	D	E

3. I analyze assumptions and biases (opinions) of myself and others.

Never	Rarely	Sometimes	Frequently	Always
A	B	C	D	E

4. I consider alternative interpretation to questions posed.

Never	Rarely	Sometimes	Frequently	Always
A	B	C	D	E

5. I recognize the limitations of a concept

Never	Rarely	Sometimes	Frequently	Always
A	B	C	D	E

Part 2

Directions: *Read the question and select the best answer.*

1. Which of these problems is most severe?

- A. Your professor is sick and misses class on the morning you are supposed to take a big exam.
- B. You lose track of your schedule and forget to study for a big exam.
- C. You can't find one of the books you need to study for a big exam.
- D. The big exam is harder than you thought it would be and includes a section you did not study.

2. Which is NOT a valid argument?

- A. There are six cans of tomatoes in Carlo's pantry and 14 in his basement. There are no other cans of tomatoes in his house. Therefore, he has 20 cans of tomatoes in his house.
- B. Everyone northbound on the Interstate yesterday was late to work. Faith was northbound on the Interstate. Faith was late to work.
- C. Huang lives in either Kansas City, Kansas, or Kansas City, Missouri. If he lives in Kansas, then he is an American.
- D. No one who eats in the cafeteria likes the pizza. My boss eats in the cafeteria. Therefore, my boss does not like the pizza.

3. For years, a considerable number of students on West County High School's track team complained about shin splints (medial tibial syndrome). However, during the most recent season, the number of students who complained about shin splints dropped significantly. School officials assert that this reduction in complaints occurred entirely as a result of the school's decision to build a new running track that provided a softer running surface, which absorbed much of the shock on the knees and shins that occurs when running and causes shin splints.

Which of the following, if true, most severely weakens the school officials' explanation for the decrease in complaints about shin splints?

- A. As a result of West County High School's adoption of better medical staff and new medical scanning devices, many students whose complaints would have been diagnosed in years past as an instance of shin splints are now diagnosed with a different condition.
 - B. West County High School built its track after a number of neighboring schools with similar track teams built new tracks and each school saw the number of complaints about shin splints drop.
 - C. This past season, members of West County High School's track team received and wore new and highly acclaimed shoes designed to soften the impact of running on the shin and knee.
 - D. This past season, the total number of students who complained of pain while running rose.
 - E. The maker of the new track claims that on average, complaints about shin splints fall 25% when its tracks are implemented.
- 4. A recent article in one of the nation's leading newspapers noted that despite the government's warning about peanut butter likely being contaminated by salmonella and the government's subsequent recall of a limited amount of peanut butter, 90% of grocery store shoppers surveyed said that they did not plan to change their peanut butter purchasing habits. Nevertheless, roughly two months after the limited recall and one month after the leading newspaper published its article, the country's peanut butter manufacturers reported that same-store sales to grocery store shoppers fell 75% year-over-year.**

Which of the following, if true, best explains the apparent paradox above?

- A. The initial survey of shoppers failed to consider the effect of subsequent cuts in the price of peanut butter.

- B. Fearing additional instances of contamination and subsequent lawsuits, many retailers that sold peanut butter removed the product voluntarily from their shelves.
- C. A report similar to the report that appeared in the leading newspaper appeared in one of the nation's tabloid magazines on the same day.
- D. Days before the newspaper conducted its survey, a widely-respected bacterial research specialist published an op-ed article in a major newspaper arguing that the threat from salmonella-infected peanut butter was smaller than the government would later contend.
- E. A study published after the government recall of some peanut butter stated that individuals intended to change the type of jelly and bread they purchased.

Note: correct answers in red.