Assessment of Learning Outcomes: AY14-S15 Summary
USF BS CHEMISTRY, COLLEGE OF ARTS & SCIENCES
On-campus program

The report consists of each of the courses and a summary of their assessments by the professor in charge (full course reports with details are filed with the Assessment Chair).
Course assessments are for all students in Courses Chem 1xx and 2xxx.
Course assessments are for chemistry majors in Courses Chem 3xx and 4xx.

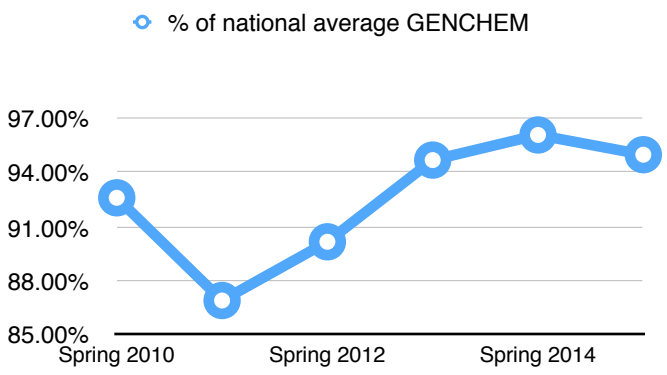
Complied and edited by LD Margerum, Assessment Chair, Fall 2015

BS Student Learning Outcomes (LO) and Methods of Measurement (Examples) have not been modified since the last cycle.

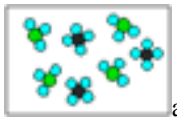
LO #1: Students will demonstrate their mastery of the four principle disciplines: analytical, organic, physical, and inorganic chemistry (and biochemistry for that concentration). Aligns with Institutional Learning Outcome 3 (Students construct, interpret, analyze, and evaluate information…)

Chair summary by course:

General Chemistry II 113: Full year American Chemical Society (ACS) Standard National Exam. Performance is consistent for the last 3 years and higher than 4-5 years ago, despite the use of many adjuncts in Chem 111/113 for the last few years. Benchmark is national average (38 vs. 37.4 +/-9.2) and it was achieved.
What will be done differently/actions taken? A concerted effort has been made by the chair and faculty to coordinate both lecture and homework assignments and to encourage faculty exchange of exam questions, otherwise each instructor independently determines the mix of lecture, group work and in-class group problem solving within the course. The OWLv2 learning system/mastery homework assignments is the same for all sections, assignments selected/scheduled each semester by Dr. Margerum. The software modules provide traditional and conceptual/visual instruction (problem types: mastery, tutorial, visual exercises) with specific feedback. The repeat until mastered philosophy forces students to put more time on task. End of Chapter textbook problems were assigned as OWL online "tests" (no feedback, 3 tries at a given type of problem, no time limits) last year based on instructor/student feedback. Built in course analytics showed USF students who attempted these required modules scored above national averages on a majority of the questions selected (n>1200-4000 for national stats) and typically scored lower than the unlimited/full feedback in-chapter modules.



Chem 112 General Chemistry I Lab: Open lab manual final exam as multiple choice via Canvas. Selected problems analyzed.

A) (limiting reagent, conceptual) Given the picture of reactants (shown)  and a balanced equation, identify new picture of products+ left over reactants (4 possible pictures). *Only 29% choose the correct picture.*
B) (bonding) Identify from a molecular formulas, which have sp2 hybridization around central atom? *42% correct*
C) (bonding, structures) Given 4 formulas + Lewis structures, pick one or more that are correct. (2/4 were correct) *77% correct*.

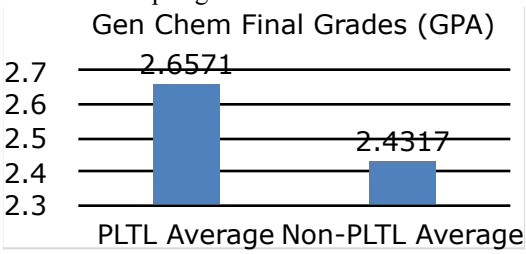
What will be done differently? Find ways for students to draw more Lewis structures during labs and continue the practice in chem 114 lab. Perhaps come up with another limiting reactant lab or add material to the existing one (conceptual).

Chem 114 General Chemistry II Lab: written lab final questions via Canvas on key concepts from experiments.

Final exam mastery of concepts (50points)	Benchmark 70% or higher
Average	40 (80%)
StdDev=	6.6
67% above benchmark	
High Score:	49
Low Score:	28
Total Graded Submissions:	144

What will be done differently? It became evident after the first few experiments that many students were coming to class unprepared and not understanding the experimental procedures. Once it was emphasized to them that on the written final they would be required to demonstrate mastery of the concepts in each experiment, their preparation improved and on the final exam the results were satisfactory.
-Many of the pre-lab questions in the laboratory manual were simply too easy and judging from the answers most students merely looked up definitions on the internet and gave verbatim answers. In future the instructor will assign his/her own questions or require procedural outline that will demand more from the students.
-More time will be spent in the first lab of the semester helping students to develop better laboratory techniques. Emphasis will be placed on the paramount importance of obtaining the most accurate data possible by being rigorous will all measurements.

Chem 191/193 Peer-Led Team Learning (PLTL for Chem 111/113): Optional workshop (1 unit, pass/fail).
Sessions were led by a student facilitator/leader trained by USF Learning Center and Dr. Joe Leonetti (adjunct) in small groups ranging using a commercial workbook from 3 to 10 students meeting for 2 hours once a week (45 students in Chem 191). Students met for 12 sessions/semester totaling in 168 student contact hours in fall and 168 student contact hours in spring.



Outcomes: **Chem 191**: The DFW rate for PLTL students was 19% while general chem DFW rate was 22%. This is consistent with the past 2 year trend: PLTL students approximately half a grade higher than their non-PLTL peers and lower DWF rate (previous years DWF rate for PLTL was ~13%.
Chem 193: 21 students completed the course with a GPA of 2.83 vs. 2.87 for non-PLTL with a DWF of 4.8% vs 14% DWF for non-PLTL.

In the end of semester survey, 79% of students "strongly agree" or "agree" with the statement that PLTL helped them better understand the material while 21% said "neutral". Some 84% said that they would recommend PLTL to a friend. Mid-semester evaluations overwhelmingly gave positive feedback for the effectiveness in understanding material.

Organic Chem 230/231: We embedded the same questions on the final for the two sections. These questions attempted to ascertain student understanding of mechanisms, spectroscopy, synthesis, comparative acidity and molecular orbital theory.

Chem 230, F14 (n=52)	Theory	Acidity	Mechanism	Synthesis	Spectroscopy
Average%-section 2	42	90	85	71	81
Average% Section-3	44	78	59	71	71
Overall	44	84	72	71	71

The theory question at 44%, is significantly below benchmark of 60%. While students were able to apply the energy diagrams for SN1, SN2, E1 and E2 mechanisms (emphasized during class), many failed to extend this to reactions other than those four course mechanisms as this question required.
What will be done differently? We need to remind students extending and coalescing large knowledge sets to solve completely new problems even if they are not emphasized on the textbook. To that end, we will try to incorporate newer concepts in later chapters to remind the students that the principles do not just apply for the earlier chapters

Chem 231 S15 (n=72)	MO Theory	Acidity	Synthesis	Mechanism	Spectroscopy
Sec 1 (%)	67	78	71	62	66
Sec 2 (%)	89	76	27	59	66
Average	78%	77%	49%	61%	66%

Only the student's ability in synthesis is significantly below our benchmark of 60%. However, this is skewed by one section's students (sec 2) doing particularly poorly on this question. Organic synthesis involves higher order problem solving skills and is often the most difficult aspect of the course for students, therefore it is not surprising that they would have the most difficulty with this question on the final.

What will be done differently? The evaluation was for all students, so one approach to help majors would be to provide more opportunities to practice multistep synthesis problem solving in Chem 233 Majors lab. Another approach would be to offer an elective course for chemistry majors that emphasizes this skill. We have improved student's ability to solve spectroscopy problems by introducing dry labs on 1H NMR in Organic Chemistry I lab (Chem. 232). We plan to give particular emphasis for intramolecular reactions in the context of multiple step synthesis.

Analytical Chemistry 260: The average score on ACS exams was 26 (+/-7) out of 50, compared to 27.5 +/-7.1 nationally. USF was at 94.5% of national average (n=14), similar to previous years and within the standard deviation. A new commercial POGIL (group guided inquiry in class) workbook was required and used heavily this year. The workbook had more in depth and conceptual + applied problems done in class or assigned as homework. Benchmark was achieved.

Five ACS exam questions 2015 students did better than 2013 students (in order)

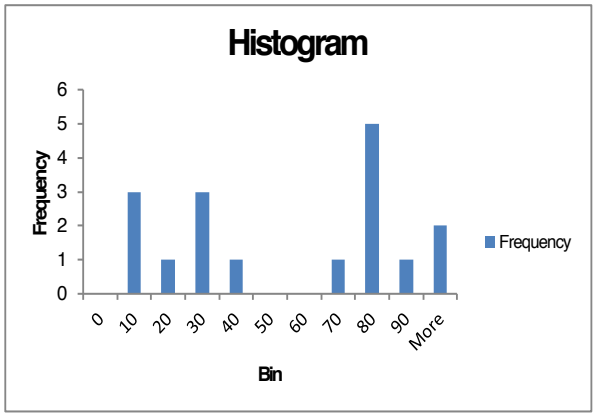
- %wt from titration endpoint data
- Confidence intervals
- Correct sig.figs from ave+/-std.dev.
- pH at equiv. point of weak acid titration
- wt% calculation after precipitation

Five questions with <20% correct answers:

- Beer's law plot with 2 different slopes: identify the more sensitive slope
- Charge balance for CaCO3 equilibria (not covered in 2015)
- Activity effects (not covered)
- Balancing redox reaction
- pH electrode care (not covered)

What will be done differently? We are not too concerned by low scores on some topics as they were simply not covered in the course or will be covered in future courses. Emphasis on basic calculations paid off with better performance on confidence intervals, SigFigs from std.dev, % wt calc. and pH calculations. Despite many Beer's Law calibrations in general chem and this course, it is clear that students do not grasp all the concepts. More emphasis in 113 and 260 is warranted. Chromatography was emphasized more this year, but still low performance on RP (reverse phase conditions) which can be emphasized more in lab.

Inorganic 420: The ACS exam covers all topics in Inorganic and our 1 semester treatment cannot cover about 20-25% of the question topics. The lecture was by an adjunct, the exam was taken in lab under a USF professor on the last day. Average score for 17 students (8 in a majors wet lab and 9 in a dry biochem majors lab) was 28.1/60 or 99.0% of national average. Yet, we see two very distinct student populations in the course (Histogram) which is not linked to either major. This causes real problems in delivering a quality experience to the students. We may be, (a) failing to identify weak students who should not be allowed onward past the lower-division, and/or (b) continuing



that problem in the Junior year by passing too many students out of Physical Chemistry onward into the senior year. The effect of a new adjunct in the course should not be discounted.

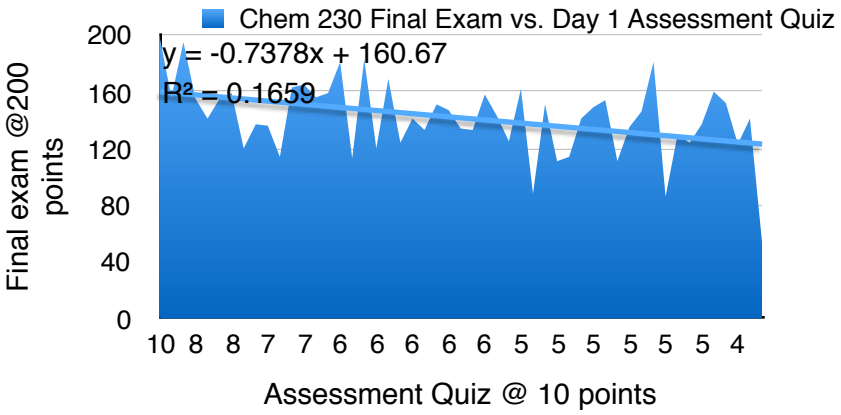
A compounding issue is that many weaker students do not take 2nd semester Physical Chemistry before taking Chem 420, if they are biochem majors, and some of the weaker students attempt to take Chem 420 while re-taking the first semester of Pchem concurrently. Perhaps a one semester Physical Biochemistry course will help in some topic areas (being discussed).

What will be done differently? Observation by the Chair: Faculty should work on potential links in the P-chem course(s) to material needed for Inorganic. Any organometallic lecture/labs in the organic sequence could also be a preview. Spectroscopy labs in Analytical Chemistry could build on general chemistry Ligand Field Theory (last topic in chem 113).

LO#2: Students will recognize and understand the concepts and skills learned in prerequisite courses at or before the start of the new course or laboratory. Aligns with ILO2 and 3 (Students construct, interpret, analyze, and evaluate information…)

Chair summary by course assessment:

Organic Chem 230: We gave an assessment quiz (10 points) at the beginning of the semester. We compare students' grades against how well they did with their final. Comparisons indicated a decent correlation between the quiz grades and the final grades. A few students who did not do too well for the assessment quiz improved by the end of the course.



What will be done differently? The poor performers at beginning need more support or some other type of help to succeed.

Analytical Chem 260: Problem Set #2 (take home) was a review of general chemistry problems (Benchmark 80%). Average score was 70% (range 30-100%) with 20-25% of students in lower end causing the average to be lower than 80%. Clearly identifies students with weak problem solving skills or time on task issues (generally the top 20% of students get >90% correct, while the bottom 20% give poor effort or do not finish).

What will be done differently? First class and/or lab checkin to emphasize links to general chemistry material and complete in class problems together. Require office hour meeting with lowest performing students to discuss learning strategies.

Chem 340, 410 and 420 were not assessed for LO#2 this year due to the use of adjunct teaching replacements.

LO#3: Students or student teams will demonstrate mastery in problem solving by performing a broad variety of analytical, computational and synthetic procedures using proper safety protocols, and will critically evaluate the results. Aligns with ILO6 (Students use multiple methods of inquiry and research processes…)

Chair summary by course assessment:

General Chem 112 Lab: A modified ACS lab final to design and carry out a semi-quantitative titration method for unknown HCl solution using a plastic transfer pipet (drop counting). Average score was 15/20 (75% correct, an improvement over slightly different mid-term practicals (11/20 or 55%) and better than 2013. This was first year with new guided inquiry lab manual using more in-lab analysis.

What will be done differently? Faculty in charge need to train the TAs to enforce Good Lab Practices with students. This involves demonstration, practice and consistent grading of data to make sure it has correct readings, units and standard deviations. The mid-term practical was useful for students to see what was expected (graded for fewer points).

General Chem 114 Lab: Compared competency in performing quantitative titration in earlier lab (#6) with competency in performing a similar titration in lab practical as part of final exam.

	Chem 114:Exp. 6 titration (25 points):	Bench mark 70%
Average	16	64%
StdDev=	7.94	
		25% above benchmark
	Lab Final titration (50 Points)	n=144
Average Score	38 (76%)	Average written+practical: 78 %
High Score:	46	95
Low Score:	29	50

What will be done differently? It was clear from Exp. 6 that students were not being rigorous enough in performing titrations. Many were not reading the burette to the correct number of decimal places and were being sloppy in achieving the correct endpoint. A similar titration was given in the lab practical final and students were warned ahead of time that they would be judged on the accuracy of their data. Each teaching assistant gave a demonstration on the correct procedure for the titration and the results improved markedly.

Organic Chem 232 Lab: (non-majors lab) Students completed an exam (laboratory and written).

- Techniques Assessment: ability of each student to work independently/safely in the laboratory for each of: Melting Point Analysis, IR Spectroscopy, Solubility Testing, and Thin-Layer Chromatography.
- Data Assessment: evaluated the ability to achieve reliable results
- The written component was also assessed in two parts (via a problem set):
  - Part A: An in-laboratory assignment through which data was compared and contrasted between pairs (in one case, a trio) of students who believed their organic solids were identical.{Note: This part completed in teams and with the guidance of the instructor / teaching assistant.}
  - Part B: A take-home critical thinking assignment: ranking the five methods of analysis according to the potential for each to provide conclusive evidence to support the assignment of the unknown

Results and Discussion: The benchmark was a score of 65% in each assignment.

	Max Possible	*Raw Mean*	*Mean (%)*	*Raw Median*	*Median (%)*	*Raw Std Dev*	*Std Dev (%)*	*Raw High*	*High (%)*	*Raw Low*	*Low (%)*	*Missed Benchmark*
Techniques	25	22.9	91.6	23.0	92.0	1.8	7.2	25.0	100.0	16.0	64.0	1
Data	20	15.7	78.5	16.3	81.3	2.5	12.3	20.0	100.0	7.5	**37.5**	11
Assignment, Part A	20	16.2	81.1	16.0	80.0	1.4	7.1	20.0	100.0	13.5	67.5	0
Assignment, Part B	15	10.6	70.9	10.5	70.0	2.2	14.7	15.0	100.0	4.5	**30.0**	33

The benchmark was missed a total of 11 times across all four assignments (3% rate). One student (1%) missed the Techniques benchmark. Eleven students (11%) missed the Data benchmark. No student teams missed the benchmark on Assignment A. Thirty-three students (34%) missed the benchmark on Assignment B.

When working together or under the guidance of the instructor, all students were able to perform an initial evaluate of their laboratory results. However, when working independently, only two-thirds of the class demonstrated higher-level critical thinking skills when executing a "pro / con- type" analysis across familiar analytical techniques.

What will be done differently? In the future, explicit utilization and comparison / contrasting of two independent techniques could be implemented in experiment(s) towards the end of the semester.

Analytical Chem 260 Lab: ACS small scale lab assessment final (modified). *"Devise, carry out and explain an experiment to determine pKa of your weak acid unknown, HA, in less than 2 hours"*

The concepts and techniques to obtain pKa were emphasized in an earlier major lab experiment/lab report. The benchmark was met by 64% (9 out of 14) of students, which is higher than in previous years (54-55%), but still lower than desired.

Strengths: 79% of students correctly stated that ½ endpoint volume is the pKa= pH; 50% reported +/- 0.3 pH units true value

Weakness: 36% of students more than +/-0.5 pH away from published value. Explanations poorly supported by data.

What will be done differently? Most students took the full 2 hours, whereas some quick methods to obtain pKa where ignored. There was student bias towards instrumental methods even when the instructions said nothing about accuracy, only "good" precision. More instructor led practice practicals on applied lab problems at the end of some experiments. Emphasis on "Keep it Simple" or only do what is necessary to answer the question.

LO#4: Students will demonstrate effective scientific communications skills in both written and oral form. Students will be able to write reports and present results while following professional policies regarding intellectual property, plagiarism, and group work. Aligns with ILO 4 **(**Students communicate effectively in written and oral forms…) and ILO5 (Students use technology to access and communicate information…)

Chair summary:

Chem 260 Lab: *Experiment 2*: Vitamin C in fruits. Memo style. Groups completed handwritten draft memo from results/instructions directly in lab notebook during lab time. Re-typed as a group and sent to another group for peer review using a rubric. Final memo uploaded to Canvas and graded by instructor. **Results**: Final memo average from 6 groups = 88%; this is above benchmark of 75%

Experiment 6: Diprotic Acid titration and analysis. Formal Full Lab Report using a detailed handout. In-lab Peer Review of Draft = 30 points(TA grading before Peer Review) + Final Report 70 pts = 100 pts. **Results**: draft + final report = 78% (lowest score 60%): at benchmark of 75%

Conclusions: Continue with forcing a draft with peer review (done in lab) that leads to better quality work. Lower scores on Exp 2 memos were mostly for poor organization and leaving out details. This was the first time many students wrote this type of report and it was very well received with most memos clearly written. Most conclusions were supported by data.

Exp. 6 formal report has been graded the same way for a number of years. Again peer review during lab time and using peer review worksheets helped improve outcomes

What will be done differently?

-turn over some lab time to student lead problem sessions before an exam or a practical. Assign a problem in advance and have the student present the solution.

-mandatory office hours for low scoring students on Problem set 1 and 2.

-find ways for students to 'correct' mistakes (redo of problem set or alternate work).

Chem 352 Biochemistry Majors Lab: Formal lab reports, in the style of an "Article" for submission to the journal Biochemistry, were written by individual students, each of whom received detailed written feedback from their peers and both written and oral feedback from the instructor (in a mandatory 1:1 meeting) on a draft report before submitting the revised version assessed herein. 65% benchmark in each category for 12 students (large StdDev).

		Max Score	*Raw Mean*	*Mean (%)*	*Std Dev*	*Std Dev (%)*	*Raw High*	*High (%)*	*Raw Low*	*Low (%)*
Introduction	Content	10	8.0	80.0	1.0	10.4	9.5	95.0	6.5	*65.0*
	Support	5	4.5	*90.8*	0.5	10.8	5.0	100.0	3.5	70.0
	Illustrations	5	4.2	84.2	0.5	10.0	5.0	100.0	3.5	70.0
	Hypothesis	5	4.1	82.5	0.8	*15.4*	5.0	100.0	2.0	**40.0**
Materials & Methods	Organization	5	4.5	*90.8*	0.5	9.0	5.0	100.0	4.0	80.0
	Presentation	5	4.3	85.0	0.4	8.0	5.0	100.0	3.5	70.0
	Content	10	7.5	*75.4*	1.5	*14.8*	9.0	*90.0*	3.5	**35.0**
	Language	5	4.8	*96.7*	0.2	*4.9*	5.0	100.0	4.5	*90.0*
Results	Content	10	7.5	*75.0*	1.7	*17.1*	10.0	100.0	5.0	**50.0**
	Context	10	8.1	80.8	1.1	10.8	9.5	95.0	6.5	*65.0*
	Presentation	5	4.3	85.8	0.5	9.0	5.0	100.0	3.5	*70.0*
Discussion	Context	5	4.2	83.3	0.8	*16.7*	5.0	100.0	2.0	**40.0**
	Purification Table	10	8.3	83.3	1.6	*15.6*	9.5	95.0	5.0	**50.0**
	Content	15	12.2	81.4	1.1	7.4	14.0	*93.3*	10.0	*66.7*
	Conclusion	5	4.1	81.7	0.8	*15.9*	5.0	100.0	2.0	**40.0**
References		5	4.1	82.5	0.6	11.4	5.0	100.0	3.5	70.0
Professionalism		10	8.9	89.2	0.9	9.0	10.0	100.0	6.5	*65.0*
	Totals	125	103.8	83.0	8.3	6.6	114.5	91.6	88.5	70.8

Strengths: use of supporting arguments from the literature for claims made in the Introduction (mean: 90.8%), organization (mean: 90.8%), past tense passive voice (mean: 96.7%; std dev: 4.9%) in the Materials & Methods.

Weakness: clear hypothesis statement in the *Introduction,* all experimental details in the *Materials & Methods,* all key data in the *Results,* the *Discussion* section as a whole.

What will be done differently? Small activities composing a hypothesis statement integrated into the weekly lab experiments in early portions of the semester. Perhaps earlier introduction to papers from the literature on topics associated with individual lab exercises could be integrated into the course

Chem 420 Inorganic Lab: Majors only Lab Report Rubric result: 3.4 out of 5 (68%). Biochem emphasis term paper: 15.9 out of 18 (88%). Benchmark generally met. The writing weaknesses were most apparent from the Chem Majors students taking the wet lab portion of the course (where the writing challenge is harder than term papers by the Biochem emphasis students). There were significant issues with poor organization, sloppy figures, poor critical thinking and ability to deduce valid scientific facts from acquired data and present good concluding summaries. There were also widespread issues concerning proper use of references to buttress arguments and underscore ideas. **What will be done differently?** Improvement areas: a) located additional resources to give the students prior to their first lab write ups b) focus more time on explaining the need for multiply-revised, carefully-considered outline and the often co-occurring problem of not revising/proofing one's final report.

Chem 397 (Undergraduate Research method and practice): Four students delivered ~15 minute oral PowerPoint presentations of their independent research projects at the USF Creative Activity and Research Day (CARD) and / or the ACS Northern California Undergraduate Research Symposium (NCURS). Scored on 1-4 scale.

	A	*B*	*C*	*D**	*Item Mean*
Vocabulary	3.5	3.5	3	4	3.5
Organization	4	3.5	4	4	3.9
Content	3.5	3.5	3	4	3.5
Speaks Clearly	3.5	4	2.5	4	3.5
Posture & Eye Contact	3	4	3	4	3.5
Used Visual Aids Well	3.5	4	4	4	3.9
Graphics – Clarity	4	4	4	4	4
Graphics – Relevance	4	4	4	4	4
Graphics – Originality	3.5	3.5	3	4	3.5
Attractiveness	4	3	3.5	4	3.6
Total	**36.5**	**37**	**34**	**40**	**36.9**

In general, students' presentations were well-organized and made good use of relevant, clear figures. some tendency to sink use some project-specific jargon without defining potentially unfamiliar terms. Other "intangibles" regarding the delivery of the presentation (i.e., speech rate) scored comparatively low in some cases

What will be done differently? Perhaps including an oral presentation component in other courses would assist the students in building their confidence in speaking in front of a group and in sprucing up the overall attractiveness of their presentations. Advance practice sessions were held in which the student presenters received recommendations on both the quality of their PowerPoint slides and their delivery of content. This feedback came from both the CHEM 397 instructor and peers in the course. Perhaps having peers evaluate their fellow students' practice presentations according to same rubric would help students who have difficulty with delivery recognize this about themselves.

LO#5: Students will apply their experience and knowledge of the discipline in the successful conduct of at least 80 hours of additional work via undergraduate research (Chem 397), Experimental Biochemistry (Chem 352), integrated Lab (Chem 410) or Chemistry Electives courses.

Chair summary:

- 13 students in 397 Undergraduate research in S15.
  - Resulting in about 4-6 hrs/week x 14 weeks = 56 - 84 hrs work for each student (juniors and seniors)
- 10 students registered for 352 Biochemistry Lab in S15:
  - 6 hrs lab/week x 14 weeks = 84 hrs/ student (juniors and seniors)
- 12 students registered for 410 Integrated Lab in S15:
  - 6 hrs lab/week x 14 weeks = 84 hrs/ student (juniors and seniors)

For AY 2014-15: 17 BS Chemistry degrees awarded
2 ACS chemistry certified
1 ACS biochemistry emphasis certified
6 non-certified chemistry
8 non-certified biochemistry emphasis

Section IV: Continuous Improvement

Indicate Actions the Program Faculty Have Taken in Response to Results
(Check all that apply)

a. Revision of PLOs: LO#5 was changed in May 2015 to "encourage majors to go beyond the minimum requirements with more in-depth electives, on campus or off campus research, or chemistry related internships".
b. Changes in pedagogical practices: General Chemistry instructors agreed to use iClickers for in-class non-graded assessments
c. Revision of program course sequence: Adopting our accrediting agency (ACS) guidelines to create different chemistry tracks (not necessarily new major degrees) with "Foundational" and "In-deptth" course work. Proposals to revise organic chemistry track and create a medicinal chemistry track were proposed Fall 2015
d. Revision of course(s) content: Ongoing based on assessment results.
e. Changes to faculty and/or staff: Replacements: New Analytical Faculty (Dr. Ryan West) and current search for New Biochemistry; New Organic Lab/NMR manager, Potential new hire: Chemistry Instrumentation Specialist
f. Modified course offering schedules: An Organic PLTL trial was somewhat successful in fall but had very low enrollment in fall. USF Learning Center wants to focus on Chem 191/193 for AY2015-16 with push for new peer leaders and higher enrollments for students.

November 2015.