Program Plan and Findings: Four Column Layout

Program (CAS) - CHEM - Chemistry: ACS Approved (BS) - 044

Program Mission Statement: The Department of Chemistry at Oklahoma State University: promotes the advancement and dissemination of knowledge that is central to many science reliant degree programs both within A&S and across College lines; nurtures the growth of future scientists through undergraduate and graduate research; supports creative endeavors in innovative instruction paradigms and scientific research by faculty and staff; enriches civilization by contributing to education and new technological developments.

Program Information

2019 - 2020

Program Information

Assessment Coordinator's Name: Jacinta Mutambuki, Ph.D.
Assessment Coordinator's E-mail Address: jacinta.mutambuki@okstate.edu
Number of Students Enrolled in the Program: 14
Total Number of Students Graduated: 3
Number of Student Graduates from Stillwater Campus: 3
Number of Student Graduates from Tulsa Campus: 0
Were university assessment funds used by the department/program for assessment activities?: Yes
If yes, describe how funds were used and the contribution the funds had on the assessment process: Funds were used for reviewing artifacts and analyzing the data.

Annual Executive Summaries

2019 - 2020

Program Assessment Coordinator: Jacinta Mutambuki, Ph.D

Plan Review and Approval

Date Current Plan Was Reviewed and Approved:
Date of Future Plan Review and Approval:

Summary of Assessment Findings

Describe overall assessment findings and faculty members' interpretation of the assessment results: Current assessment results reveal that the preparation pathway for students in the ACS degree Chemistry major appears to be operating as intended. The two students assessed in the program demonstrated 3.5/5 mean rating scoring on the assessed SLO1. This means that 100% of the assessed students met the assessment outcome. However, the sample size is not representative of the student population in the program. Out of a total of 34 ACS Chemistry students enrolled in the program during this assessment period, only a handful registered in the CHEM courses of assessed.

Results also revealed that communication of research findings in the form of written reports (e.g. CHEM 4990) were reasonably adequate. There are potential deficiencies in developing student skill in graphical presentation of. Scientific thought, support, construction of text, and organization of the written word are all well demonstrated in written reports, indicating that students are applying their interpretation and language skills quite well. The added consideration of the broader scientific literature appeared to differentiate this degree path from the Departmental Degree path. These findings indicate that students are receiving the necessary skills to successfully complete this degree path, though more dedicated mentorship could improve future student performance.

Dissemination of Findings

Describe the individual(s) or committee responsible for reviewing and interpreting assessment data: Drs. Jacinta Mutambuki and Christopher Fennell.
Describe the process for sharing and discussing assessment findings with program faculty: The assessment results will be discussed during a general chemistry faculty meeting

Program Improvements Based on Assessment

Based on data collected this year, what changes are being considered or planned for the program?: Results will be shared with the chemistry faculty to deliberate on suitable adjustments in designing course assessments tailored to the student learning outcomes. Sometimes, specific categories to the SLOs are not measurable, so faculty will discuss the alignment between the SLOs and the assessments in the course.
Based on this year's findings, what (if any) changes are planned for the assessment process?: The Assessment Committee suggests a number of changes to improve the data collection process in the near future. First, plans are underway to collect copies of the relevant artifacts for assessment in the subsequent assessment period before professors return them to students. Second, the assessment team will work with the instructors to collect screenshots of students' work on their thought processes during problem solving in multiple-choice type of exams. Third, for future assessments, we will administer a survey to students in the program to uncover their experiences in the program and suggestions for improvement.
Describe the process for implementing these changes/planned program improvements: For data collection improvements, the assessment team will work with the program advisor to identify students enrolled in the program and the courses they are enrolled in each semester. This will ensure timely follow up with the course instructors to collect the assessment artifacts before they are returned to the students. This effort will be implemented each semester to ensure adequate sample is realized for analyses.

To overcome the challenges of multiple-choice questions following remote instruction, course instructors will be encouraged to request the students to submit screenshots of their reasoning processes on problem-solving questions to enable analysis of scientific reasoning and critical thinking skills on closed-ended questions. We found this approach useful from CHEM 1515 in which the two students were assessed.

A student survey will be administered through Qualtrics to capture students' experiences in the program including barriers to excelling in the program (CHEM courses), and any suggestions for future improvement of the program.

Program Improvements Made in the Last Year: Course Improvements
"Other" Improvements:
Goals for the Coming Year: Revise the assessment plan and obtain faculty buy-in on data collection.
Is this Summary Report Complete?: Yes
List all individuals associated with this report preparation: Drs. Jacinta Mutambuki and Christopher Fennell.

Outcomes	*Assessment Methods*	*Findings*	*Use of Findings (Actions)*
SLO1: Knowledge - Students will know and be able to apply scientific	**Analysis of Written Artifacts -** A total of 9 chemistry majors enrolled		

Outcomes	Assessment Methods	Findings	Use of Findings (Actions)
reasoning to principles important to foundational concepts in chemistry. **Outcome Status:** Active **Planned Assessment Year:** 2016 - 2017, 2017 - 2018, 2018 - 2019, 2019 - 2020, 2020 - 2021, 2021 - 2022, 2022 - 2023 **Start Date:** **Archived Date:** **Outcome Type:** Knowledge **Reason for Archival:**	in the BS-ACS degree were included. Two students were from CHEM 1314 (Spring 2019 and Summer 2019), two students were from CHEM 3053 (Fall 2018) and six were from CHEM 3433 and 3553 (Fall 2018 and Spring 2019). A list of undergraduate chemistry majors was obtained from the Department of Chemistry, including information about the courses they took during Fall 2018, Summer 2018, and Spring 2019 semesters. The identified chemistry majors enrolled in the courses of interest (CHEM 1314, 3053, 3433, and 3553) during these semesters were included in the assessment of this outcome. Assessments involved rating students' artifacts and correlational analysis on formative assessment. The latter was only implemented in CHEM 3433 and 3553. For analyses of artifacts, three chemistry faculty members and one graduate chemistry student were involved. The artifacts were mainly exam questions from the final exam or from both final and midterm exams on the courses previously mentioned. Two raters independently assessed the artifacts against a Scientific Reasoning and Critical Thinking Rubric, which is attached in the Appendix section and discussed the rating scores. For example, for CHEM 3433 and 3553, one faculty and the graduate student independently rated 104 artifacts of six chemistry majors and		

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	discussed the generated rating scores. Differences in the rating were discussed and resolved, with an agreement of more than 90% reached. Similar procedure was applied in rating artifacts from CHEM 3053 (4 artifacts of two students on a cumulative final exam only) and CHEM 1314 (9 artifacts of one student; five from final exam and four from a midterm exam) in which two faculty members were involved. The artifacts were scored on six components (if at all present on the artifacts), namely: Understanding of Problem; Graphical Interpretation; Calculations; Solution and Data Interpretation; Answer and Use of Terms; and Representations and Models. The rating scale on these components were 1 (least score), 3, and 5 (highest score); however, a score of 2 and 4 were assigned if the assessed artifact displayed characteristics features between 1 and 3, and between 3 and 5, respectively. Finally, the faculty reviewed the final tallied scores from all the artifacts to ensure the rating were done within the scale and no reporting errors on the scores. The formative/summative correlation effort was also made in an attempt to evaluate a pilot effort to potentially improve student success in the historically challenging/troubling Physical Chemistry sequence. In this course pairing, students are grouped with		

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	engineering students that have already had significantly greater preparation in foundational course concepts, often placing ACS (and Departmental) Degree Chemistry majors at an initial disadvantage. This pilot effort involved the introduction of a 4th midterm exam, this to distribute the summative assessment workload over smaller allotments of course material, giving the Chemistry majors a more manageable study workload before examinations. Correlation analysis of in-class formative assessment versus summative assessment was performed, though the major numbers changed from four students in 2017/2018 to eight students in 2018/2019. The difference between years leads to added statistical uncertainty for results from the 2017/2018 academic year, though the results appear to be significant enough to draw unbiased conclusions regarding the pilot effort. *** Learning Outcome** **Goal/Benchmark:** 75% of students will receive aggregate 3.5 or higher score across all the categories using the science reasoning and critical thinking rubric. **Timeline for Assessment:** Every Year **Other Assessment Type:** Rating of skills (e.g., rubrics), and Formative/Summative Assessment Correlation Analyses **Related Documents:** Science Reasoning and Critical Thinking Rubric.docx		

Outcomes	Assessment Methods	Findings	Use of Findings (Actions)
	Analysis of Written Artifacts - One graduate student and one faculty were involved in the analysis of the artifacts. The two individuals together identified exams questions that could be assessed using the Scientific Reasoning and Critical Thinking Rubric, which is attached in the Appendix section. The artifacts were scored on six components (if at all present on the artifacts), namely: Understanding of Problem; Graphical Interpretation; Calculations; Solution and Data Interpretation; Answer and Use of Terms; and Representations and Models. The rating scale on these components were 1 (least score), 3, and 5 (highest score); however, a score of 2 and 4 were assigned if the assessed artifact displayed characteristics features between 1 and 3, and between 3 and 5, respectively. The two individuals together coded three exam questions, and the rest were coded by the graduate student. The coded artifacts and the rating scores were audited by the faculty member to ensure accuracy in coding. Discrepancies in coding were discussed and resolved, with 100% agreement reached. Tallying of the scores was performed by the graduate student. For example, for a given artifact item, if we had let's say X questions which had a "calculation" component and the student could answer only Y questions correctly, then a score of Y/X proportion was given for the	**Reporting Period:** 2019 - 2020 **Conclusion:** 3 - Meets Program Expectations (Proficient) Results indicated an average mean rating score of 3.6 ±0.2 (average with standard deviation) on the SLO 1, science reasoning and critical thinking skills, for the two assessed students in the ACS degree pathway (Table 2, Appendix). This means that 100% of the assessed students met the assessment outcome. However, the sample size is not representative of the student population in the program. Out of a total of 34 ACS Chemistry students enrolled in the program during this assessment period, only a handful registered in the CHEM courses of assessed. Artifacts for the two students were obtained from CHEM 1515 enrollment in spring 2020. A total of N=23 artifacts each were selected for scoring each individual component in the rubric. The data outcome when compared to the last year provide mixed insights: 1) the performance for the students in CHEM (ACS) major slightly dropped by 0.1 point, and 2) there's a subsequent increase in the individual components like "calculation" and the "understanding of the problem" by 0.5 point each. It is to be noted that last year's assessment had n=9 students & N=117 artifacts in total. Also, the fact that we did not have any data for assessing the component E, "Answer & use of terms", this year was due to unavailability of physical artifacts and the sole method of assessment for this group was a little bit different due to remote instruction during Spring 2020 session. (09/13/2020) **Number of Students Assessed:** 2 **Number of Successful Students:** 2 **How were students selected to participate in the assessment of this outcome?:** A list of undergraduate ACS chemistry majors was obtained from the Department of Chemistry, including information about the courses they took during Fall 2019 and Spring 2020 semesters. The identified chemistry majors enrolled in the courses of interest, such as CHEM 1314, 1515, 2122, 3053, 3112, 3153, 3353, 4020, and 4990 during the two semesters were	**Use of Findings (Actions):** Results suggest that there is room for improvement on this outcome as all students scored 3.5 mean rating scores on four of the five dimensions assessed. (09/13/2020)

Outcomes	Assessment Methods	Findings	Use of Findings (Actions)
	calculation component to the student. Finally, the faculty reviewed the final tallied scores from all the artifacts to ensure the rating were done within the scale and no reporting errors on the scores. For Fall 2019, most instructors handed back the student artifacts immediately after grading; thus, making it difficult to assess a large pool of students for this degree program. A total of 17 out of 61 students (~ 28%) enrolled in the program were assessed during this period. The assessed students were enrolled in CHEM 1314, 1515, 3053, 3112, 3153, 3353, and 4990 during this assessment period. A total of 102 artifacts measuring specific components of the SLO 1 were included in the analyses. *** Learning Outcome Goal/Benchmark:** 75% of students will receive aggregate 3.5 or higher score across all the categories using the science reasoning and critical thinking rubric. **Timeline for Assessment:** Yearly **Other Assessment Type:**	considered in the assessment of this outcome. **What do the findings suggest about student achievement of this learning outcome?:** Overall, current results suggest that the preparation pathway for students in the ACS degree Chemistry major appears to be operating as intended and providing necessary preparation for student success beyond OSU undergraduate studies. This does not mean that there are not potential areas for improvement. **Related Documents:** Science Reasoning and Critical Thinking Rubric.docx Table 2 A Summary of Mean Rating Scores for ACS Chemistry Majors on SLO 1.pdf	
SLO 2: Problem Solving - Students will be able to critically analyze and solve problems **Outcome Status:** Active **Planned Assessment Year:** 2016 - 2017, 2017 - 2018, 2019 - 2020, 2020 - 2021 **Start Date:** **Archived Date:** **Outcome Type:** Skills	Student artifacts were collected during the Spring, 2017 semester in CHEM 3112. Student names will be redacted from the artifacts. Critical thinking skills were assessed using a modified science reasoning rubric developed in the Chemistry Department. *** Learning Outcome Goal/Benchmark:** 70% of students		

Outcomes	Assessment Methods	Findings	Use of Findings (Actions)
Reason for Archival:	will receive a 3, 4 or 5 using the science reasoning rubric **Timeline for Assessment:** Yearly **Other Assessment Type:**		
SLO 3: Writing Communication Skills - Students will be able to demonstrate proficiency in writing skills and accurately apply scientific literature in completing their project in CHEM 4990 **Outcome Status:** Active **Planned Assessment Year:** 2019 - 2020, 2020 - 2021, 2021 - 2022, 2022 - 2023 **Start Date:** 08/19/2019 **Archived Date:** **Outcome Type:** Skills **Reason for Archival:**	**Rating of Skills -** A list of undergraduate students enrolled in the CHEM (ACS) degree path was obtained from the Department of Chemistry, including information about the courses they took during Fall 2019 and Spring 2020 semesters. The identified chemistry majors enrolled in CHEM 4990 during the two semesters for which final reports returned by mentoring faculty were considered in the assessment of this outcome. *** Learning Outcome** **Goal/Benchmark:** 75% of students will receive an aggregate 2.5 or higher score across all the categories using the assessment of written reports rubric. **Timeline for Assessment:** Yearly **Other Assessment Type:**	**Reporting Period:** 2019 - 2020 **Conclusion:** 1 - Does Not Meet Program Expectations (Unacceptable) Results indicated an average mean rating score of 2.9 ±0.4 (average with standard deviation) on the SLO 3, science writing skills for all the students assessed for this degree pathway (Table 2). The mean rating was higher than the expected value by a 0.4 point. Overall, four components of the SLO, “Critical Thinking”, "Scientific Support", "Organization", and “Grammar/Spelling” showed mean rating scores above the projected mean, 3.3, 2.7, 2.7, and 3.3 respectively. The remaining component, "Visual Presentation" scored exactly at the expected mean (Table 2). (09/13/2020) **Number of Students Assessed:** 6 **Number of Successful Students:** 3 **How were students selected to participate in the assessment of this outcome?:** CHEM 4990 reports for n=6 students across Fall 2019 and Spring 2020 were included in the assessment of this SLO. **What do the findings suggest about student achievement of this learning outcome?:** Current results suggest that the preparation pathway for students in the CHEM ACS degree is encouraging, but three components ("Scientific Support", "Organization", and "Visual Presentation") do not greatly exceed the middle point expectation set by the rubric for written reports (Appendix IV). Of the reports considered only 50% of the students exceeded this middle point threshold, not the desired 75%. Findings indicate students are meeting expectations in many cases, but there is a potential need for improvement in visual communication of data. The fact that 50% of sampled student artifacts fell below the middle point threshold is concerning and may indicate a need for more dedicated effort supporting the less prepared students that enter the CHEM ACS degree program.	**Use of Findings (Actions):** Findings indicate students are meeting expectations in many cases, but there is a potential need for improvement in visual communication of data. The fact that 50% of sampled student artifacts fell below the middle point threshold is concerning and may indicate a need for more dedicated effort supporting the less prepared students that enter the CHEM ACS degree program. (09/13/2020)

Outcomes	Assessment Methods	Findings	Use of Findings (Actions)
		Related Documents: BSDegrees_Written Report Rubric.pdf	