Program Name: Life Science – Chemistry Education

Assessed by: Jeff Goff, Dept. of Natural Sciences

Date/Cycle of Assessment: Submitted on 1/8/2021;
Reporting cycle of January 2019 – December 2019

Mission Statement:

The Malone University Department of Natural Sciences exists to engage students in the study of God's majesty and character by exploring His handiwork as it is revealed in Nature, both animate and inanimate; to promote the wise and thoughtful stewardship of the natural resources He has entrusted to us; and to encourage students to demonstrate God's love in their respective communities by using the knowledge and skills they acquire here.

Program Goals:

- Students should comprehend the central concepts of biology and chemistry, the underlying assumptions of biological knowledge and chemical knowledge, and be able to employ the methods of inquiry commonly utilized by practicing biologists and chemists at a level sufficient for competent teaching at the high school level (Stems from Malone Educ. Goals A4, D1, and D3).
- Students should become proficient in solving biological and chemical problems using both quantitative and qualitative approaches and in analyzing / interpreting data generated by experimental protocols commonly employed by practicing biologists/chemists (Stems from Malone Educ. Goals C3, D4, and D5).
- Students should be able to apply the principles of Christian Stewardship to biological practice and interpret biological and chemical phenomena within a Christian worldview (Stems from Malone Educ. Goals D2, E1, and E5).

MALONE UNIVERSITY ANNUAL ASSESSMENT REPORT (See Appendix for Raw Data and Detailed Analysis)

Department: *Natural Sciences*
Program: *Life Science – Chemistry Education*
Assessed by: *Jeffrey M. Goff - Dept. of Natural Sciences*
Time Period Covered: *January 2019-December 2019*
Submission Date: *1/8/2021*

Program Intended Learning Outcomes (PILO)	Means of Program Assessment & Criteria for Success	Summary of Data Collected	Use of Results
Demonstrate the capability of integrating data and assessing phenomena within a Christian paradigm (Departmental Outcome A).	1) Average cumulative score $\geq$ 12; minimum cumulative score of 8; no individual component score of 1 on the Faith and Learning Assessment Instrument as scored by the associated rubric.	Average composite score = 14.17; minimum composite score = 10; all individual component scores were 2 or higher.	Average composite score, all individual composite scores, and all individual component scores met the departmental criteria for success. No changes to curriculum deemed necessary. Nevertheless, some changes to the wordings of the prompts are anticipated due to the fact that some student responses indicated a misunderstanding of the prompts.
Demonstrate a comprehension of the central concepts of chemistry including the major theories and laws which govern chemical phenomena (Departmental Outcome B).	1) Mean score no lower than 0.5σ below national mean and no individual score lower than 1.5σ below the national mean on the ACS Gen Chem II Exam when administered as a post-test. 2) Average Cohort score on ACS Gen Chem II Exam should show at least a 70.0% improvement over the average cohort score when used as a pre-test.	1) Mean score on the ACS Gen Chem Exam is 33.06 (-0.44σ). This year, three students failed to meet the -1.5σ criterion with scores of -1.55σ, -1.64σ, and -1.91σ. 2) Class average on ACS Gen Chem pre-test is 18.30 giving strong evidence of student improvement (80.7% improvement in score from pre-test to post-test).	This year, the class average met the –0.5σ criterion, but we had three individual scores that failed to meet the –1.5σ criterion. Although the individual scores are disappointing, the cohort average is higher than 7 cohort averages collected over the last 12 years. Although several reasons were listed in the appendix in support of the fact that results on this instrument need to be used "with a grain of salt", we are encouraged by the improvement. The improvement over the last 2 years might possibly reflect the introduction of the new, alternative "Zoo Chem" option for Zoo & Wildlife Biology majors. Over the next year or 2, the efficacy of this curriculum change should become more conclusive. The department has opted to postpone any remedial chemistry course development until this time window is complete. The ACS Gen Chem II pre-test scores, when compared to the post-test scores, are extremely strong evidence that our students are improving as a result of our freshman chemistry sequence. The department has concluded that whether or not our students enter below the national average, they show significant improvement in content knowledge as a result of this course sequence. STEM readiness scores for this cohort suggest that only 35% of the class was "ready" for Chem 131.

Demonstrate an understanding of the relationships between structure and behavior of the chemical elements in their various forms and combinations (Departmental Outcome C).	1) Mean score no lower than 0.5σ below national mean and no individual score lower than 1.5σ below the national mean on the ACS Organic Chem Exam. 2) Mean score no lower than 0.5σ below national mean and no individual score lower than 1.5σ below the national mean on the ETS chemistry exam Organic sub-category.	1) Mean score on the ACS Organic Chem Exam was 32.14 (–0.58σ). No individuals failed to meet the -1.5σ criterion. 2) Average sub-score on the Organic section of the ETS chemistry exam was 48.0 (+0.01σ). No individuals failed to meet the –1.5σ criterion on the organic section.	1) The results this year seem to be anomalous. Although no single student missed the individual minimum standard, the collective cohort average slightly missed the minimum standard. Furthermore, this cohort's average ACS Organic Exam score was the lowest documented over the last 10 years. 2) ETS Organic sub-scores were acceptable this year. The conflicting results from our two assessments have given us pause as we reflect on potential changes. Given the historic success on these two instruments (and no changes in the curriculum), the department has opted to not make any changes to the curriculum at this time. We simply need to see if this is an anomaly or the beginning of a downward trend.
Demonstrate safe laboratory practices and an environmental ethic as it pertains to chemical use and disposal (Departmental Outcome D).	Minimum scores of 20, 21, and 24 must be obtained respectively on 3 safety projects completed as a component of our Chem 201 course (Stewardship and Safety in Chemical Practice) and graded via associated rubrics. In addition to the composite scores criteria on all 3 projects, minimum individual element scores have also been set.	All 3 students reached the minimum score of 20 on Safety Project #1. In addition, no individual element score missed the standard. On Safety Project #2, all students who completed the course met the minimum composite score criterion of 21, and all individual element scores met the standard as well. On Safety Project #3, all students met the minimum composite score criterion of 24, and all individual element scores missed the minimum standard as well.	1) All composite scores and elemental scores met the standard. These results stand in contrast to the results from the last several offerings of the course and seem to reflect positively on the curricular change that was implemented prior to this iteration of the course (an extra credit hour was added to the course). The shortcomings mentioned in previous reports have now, we believe, been sufficiently addressed, and no individual element scores are expected to miss the minimum standard in the future. No further changes are warranted at this time.

Demonstrate an ability to analyze various kinds of experimental data used in the chemical disciplines including the output of various instrumental techniques (Departmental Outcome E).	1) Each student must obtain a minimum cumulative score of 15 on each of 6 instrumental assignments (i.e., GC instrument administered in Chem 221 and IR/MS/NMR assignments administered in Chem 322).	All students who passed the class met the minimum score of 15 on all 6 assignments.	This report contains data from the GC instrument for the first time, though data from the other 5 instruments have been collected for several years. An additional 3 instrumental assignments are anticipated to address the comments made at the last programmatic review. The chemistry faculty were hoping to implement these new assignments within the next one or two reporting cycles. The timeline for implementation may be delayed somewhat due to the retirement of one chemistry faculty and the fact that his replacement left after only one semester. At the moment, however, no changes are warranted other than those already in motion.
Demonstrate an understanding of the biological characteristics of each of the major kingdoms (Departmental Outcome F)	1) Mean score no lower than 0.5σ below national mean and no individual score lower than 1.5σ below the national mean on the ETS biology exam Organismal Sub-score.	1) Average Organismal sub-score is 58.8 ($+0.50\sigma$). No individuals failed to meet the -1.5σ criterion.	In light of the successful scores of several recent cohorts on the organismal sub-section of the ETS, the department has opted to not make any programmatic changes at this time based on this instrument. Individuals missing the criterion of -1.5σ on other sub-sections or even as composite scores are a concern for us, but legitimate reasons for individual students missing the cutoff (e.g., illness, test anxiety) do exist. The institutional cohort averages on this section are some of the highest and represent strengths of the department's biology programs.

Demonstrate an understanding of the fundamental concepts of molecular biology and genetics (Departmental Outcome G).	1) Mean score no lower than 0.5σ below national mean and no individual score lower than 1.5σ below the national mean on the ETS biology exam Molecular Biology and Genetics sub-scores.	1) Average Molecular Biology/Genetics sub-score is 54.3 (+0.06σ). One individual failed to meet the –1.50σ criterion (–1.95σ).	The average sub-score has increased significantly from last year's value giving strong evidence that last year's score (lowest since 2009) was anomalous. This year, the cohort average meets the departmental standard of –0.5σ. Nevertheless, the fact that 1 student failed to meet the –1.5σ criterion is unsettling. The department has had multiple, at-length conversations regarding students who successfully complete the curriculum and manage to miss minimum scores on standardized tests at graduation. Last year's report stated that "Departmental action is anticipated in some form by the next report (i.e., setting minimum grades for specific courses and/or limiting the number of course repeats might prevent this from recurring)." This has proven to be more difficult than anticipated. Although a minimum grade (C–) in Biol 147 is now a requirement for admission into Biol 254, this might not significantly impact performance in Biol 372 and Biol 375 content. Further conversation and potential action is likely warranted, and the department has agreed to continue this conversation.
Demonstrate an understanding of the various factors that impact biological populations (Departmental Outcome H).	1) Mean score no lower than 0.5σ below national mean and no individual score lower than 1.5σ below the national mean on the ETS biology exam Population Biology/Evolution/Ecology sub-score.	1) Average Population Biology/Evolution/Ecology sub-score is 52.5 (+0.09σ). All individuals met the -1.5σ criterion.	In light of the successful scores of several recent cohorts on the population biology/evolution/ecology sub-section, the department has opted to not make any programmatic changes at this time. Individuals missing the criterion of –1.5σ on other sub-sections or even as composite scores are a concern for us, but legitimate reasons for individual students missing the cutoff (e.g., illness, test anxiety) do exist. The institutional cohort averages on this section are some of the highest and represent strengths of the department's biology programs.

Demonstrate an ability to properly relate biological structure and function (Departmental Outcome I).	1) Mean score no lower than 0.5σ below national mean and no individual score lower than 1.5σ below the national mean on the ETS biology exam Cell Biology sub-score.	1) Average Cell Biology sub-score is 50.9 (–0.12σ). Two individuals failed to meet the –1.5σ criterion.	This sub-section of the ETS has historically been our lowest and this is true again this year. For this reason, a curricular change was proposed and passed by the full faculty that added one credit hour to the introductory Cell Biology course. This year represents only the third year that this curricular change would be expected to have any bearing on assessment scores of graduating seniors. Several years will be required, though, before the results could approach statistical significance. Furthermore, two students who completed an entire Malone biology curriculum missed the criterion of –1.5σ this year. Last year's report stated that "Departmental action is anticipated in some form by the next report (i.e., setting minimum grades for specific courses and/or limiting the number of course repeats might prevent this from recurring)." The department has since implemented a minimum grade of C– in Biol 147 as a threshold for admission into Biol 254. The department is content, at the moment, to see if this implemented change has the desired impact on the issue of the occasional poor student completing the program.
Demonstrate the capability of working with animals in safe and ethical ways that conform to state and national guidelines (Departmental Outcome J).	1) Minimum score of 35/60 on an Animal Care Portfolio with no single sub-score lower than 2.	1) All Animal Care Portfolio composite scores met the departmental criteria for success, and all individual element scores did as well. Minimum score this year was 43/60 and only 1 out of 108 sub-scores was a 2 (2s are acceptable).	Similar comments here as in reports from last 2 years. In short, the apparently onerous nature of this instrument in the eyes of our students has prompted the faculty to begin discussions about the future of this instrument. Some lessening in the rigor of this instrument is expected in the future. Suffice it to say that, while all minimum standards were met again this year, changes in the instrument are anticipated.

Demonstrate the capability of analyzing and reporting empirical data from the biological sciences (Departmental Outcome K).	Instrument has been dropped in favor of a newer one that has yet to be developed.	NO DATA	Previous reports have indicated that our department has been having a long and rather continuous conversation about the need to implement a research methods course. This course was developed and approved by the department and full faculty. This course ran for the first time in Fall 2016. The exact nature of the assessment instrument is still in flux, but the department has completed the most difficult step in addressing this shortfall. The instructor of this course has indicated that a specific instrument designed to address this Program Intended Learning Outcome is possible, and several instruments have been deployed within the course. To date, however, a departmental assessment addressing K is still in flux. The instrument should be in place with first data collection by Fall 2020.
Demonstrate the level of content mastery required for potential successful performance in secondary science education (Departmental Outcome O).	1) 100% passing scores on appropriate OAE test.	No New Data since we have no new graduates from this program	Malone has a long history of 100% pass rates on the Praxis II tests. The fact that one student failed the newer OAE test in 2015, though disappointing, does not warrant any programmatic changes at this time. However, the possibility that the OAE test might be more rigorous than the older Praxis II test is something the department must consider and be proactive about. If another student fails this test within the next 3-5 years, the department believes that a much more serious response is in order. Incidentally, the student who failed this test retook the test and passed it at a later date.