Final Report
DUE Assessment Grant Program
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Project Title: Implementation Plan for the Assessment of Student Learning Outcomes for the Chemistry Major.

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Statement of the Assessment Project:

Faculty members in the Chemistry Department have identified and itemized a list of nine *knowledge-based*, *performance/skills-based*, and *affective* student learning outcomes desired of all our graduating chemistry majors. We have generated matrices of alignment, to determine individual courses in the core curriculum that develop these outcomes, and we have selected assessment and evaluation measures for each of the learning outcomes. One of the most important tools we will use to directly assess student learning is an electronic portfolio of student work. Our plan is to collaborate with NACS to develop and set up this portfolio. In this portfolio, key work (final exams in core chemistry classes, lab reports in selected labs, samples of student work in Chem 5, literature reports, etc.) will be compiled electronically for all chemistry majors. An Assessment Committee comprised of faculty members will determine what materials will be collected each quarter, and they will analyze the data to assess student learning outcomes. Another important tool to indirectly assess student learning is an alumni survey, which will be given to graduating seniors and alumni to find out if graduates are able to successfully pursue their career objectives. An expertly crafted online survey is expected to provide a wealth of information on whether our graduates are adequately prepared for a scientific career, graduate school, teaching, or work in a related career following graduation. We would like hire an expert in this area to write our survey so that we can extract the most information possible from our graduates.

Progress towards this goal:

1. We have completed implementation of the electronic portfolio, and have begun collecting work for this portfolio. Exams for all chemistry classes are currently scanned by the Document and Delivery Management Service on campus, and scanned exams are returned to students via the eee dropbox utility. In collaboration with NACS, we have created an automated system to detect these files, and place them in a chemistry repository where they are sorted by student ID number and stored for the duration of the quarter. We also purchased a server housed in the Physical Sciences Computer Support facility, which automatically backs up these files and provides long-term storage for our Electronic Portfolio files.
2. We have crafted a preliminary rubric to assess files in the electronic portfolio (see below.)

3. The assessment committee met for the first time in May to for a preliminary assessment of two learning outcomes for a select group of chemistry majors. We ran into several problems which we will need to address before we can successfully evaluate students:

- Compliance for scanning select laboratory reports was poor, thus we were unable to evaluate any performance/skills-based learning outcomes (learning outcomes 5-8.)
- The quality and usability of the scanned finals was very uneven. In one class, the scanned final consisted of essentially a one page scantron with no questions included. In another class, only answers were scanned. We could not use these exams at all. Other finals did not include total possible points or the name of the instructor. We are working with DDM (Document and Delivery Management) to redesign the cover sheet to include both instructor and total possible points, and we will have to be more clear to faculty about the information that we need to get from the scanned exams. After implementing theses changes, we are confident that we will have created a robust system for automatically placing students' files in an electronic portfolio, for use in assessing student learning outcomes.
- It was relatively easy to retrieve a small sample of students' portfolios, but it took a very long time to print out the files, which are scanned in full color. We may end up looking at the files directly on the computer to save time, or have a staff member print the files beforehand.

4. Additional first assessment findings:

Although the goal of the first assessment was to ensure that the framework for our electronic portfolio is in place, the students' files are easy to retrieve, and the initial draft of the rubric is acceptable, we have already begun to see some deficits in one aspect of our students' learning. Specifically, we have found that students are not learning and/or retaining a key skill, the ability to perform stoichiometry calculations, past their freshman year. This is a topic that is covered extensively in high school, and some instructors feel that it is assumed knowledge upon entering college, so they do not cover it. We are finding that sophomores can no longer do these rudimentary calculations. We now have the opportunity to address this shortcoming, and easily see if our strategies for alleviating this problem are effective.

Remaining Goals:

1. Ultimately, we want to assess students at the time of graduation. We have already collected Gchem and Ochem files for our current chemistry sophomores, but we need to improve the quality of the files and increase compliance through better communication with faculty so that we will be ready for our assessment of the first cohort of seniors in two years.
2. We still need to find an assessment expert to help us design the Alumni Survey for this same group of seniors.

How we propose to sustain this project after the initial funding period:

The cost to collaborate with NACS and an outside consultant was incurred the first year only. The electronic portfolio is in place, and once the survey is written, the program will be self-sustaining. The chemistry department has been scanning exams for over two years already.

The departmental Assessment Committee will be formed with rotating membership each year, and after the initial funding period, this committee will continue to analyze assessment data from exams, lab reports, student oral and written reports and presentations, and the Alumni Survey. The Assessment Committee will summarize its assessment activities at the end of each academic year and will then report the results to the Chemistry Department at a faculty meeting called for this purpose. It will make recommendations on how the major could be strengthened. The Department will decide upon and carry out appropriate follow-ups to all assessment activities.

Proposed Learning Outcomes:

The major in chemistry provides training for students planning careers in the chemical sciences and also for those whose interests lie in biology, medicine, earth sciences, secondary education, business, and law. The curriculum of the Department is designed to satisfy the diverse needs of these students. Advanced coursework and educational activities outside the traditional classroom, such as independent research provide students the opportunity to conduct individual research projects or participate as member of a research team.

At graduation, chemistry majors should have a set of fundamental competencies that are *knowledge-based, performance/skills-based,* and *affective*.

Knowledge-Based

1. Graduates will be able to master a broad set of chemical knowledge concerning the fundamentals in the basic areas of the discipline (organic, inorganic, analytical, physical and biological chemistry).
2. Graduates will be able to solve problems competently by identifying the essential parts of a problem and formulating a strategy for solving the problem. They will be able to rationally estimate the solution to a problem, apply appropriate techniques to arrive at a solution, test the correctness of the solution, and interpret their results.
3. Graduates will be able to use computers in data acquisition and processing and use available software as a tool in data analysis.
4. Graduates will be able to use modern library search tools to locate and retrieve scientific information about a topic, chemical, chemical technique, or an issue relating to chemistry.

Performance/Skills-Based

5. Graduates will be able to understand the objective of their chemical experiments, properly carry out the experiments, and appropriately record and analyze the results.
6. Graduates will be able to use standard laboratory equipment, modern instrumentation, and classical techniques to carry out experiments.

7. Graduates will know and follow the proper procedures and regulations for safe handling and use of chemicals.
8. Graduates will be able to communicate the concepts and results of their laboratory experiments through effective writing and oral communication skills.

Affective

9. Graduates will be able to successfully pursue their career objectives in advanced education in professional and/or graduate schools, in a scientific career in government or industry, in a teaching career in the school systems, or in a related career following graduation.

Matrices of Alignment:

An electronic portfolio of student work has been set up for each student majoring in chemistry in the Department. The Assessment Committee has determined what materials (including copies of final exams, laboratory reports, term papers, etc.) will be electronically collected each quarter and placed in the student's electronic file. Assessments of student learning outcomes will use the materials in the student portfolios, as well as other individual student activities (e.g. oral presentations, poster sessions). In addition, an Alumni Survey will be given to graduating seniors and alumni to find out if graduates are able to successfully pursue their career objectives.

Learning Outcomes	Assessment & Evaluation Methods
1	Final exams in Chem 1A-B-C (or H2A-B-C), Chem 51 A-B-C (or H52A-B-C), Chem 130A-B-C (or 131A-B-C), Chem 107, Chem 151 will be reviewed for randomly selected students for appropriate content knowledge.
2	A portfolio of final exams in Chem 130A-B-C (or Chem 131A-B-C), Chem 107, Chem 151 and laboratory reports in Chem 107L and Chem 151L will be evaluated.
3	Students will successfully complete computational problems or computer modeling exercises in Chem 5. Samples of student work products will be collected and evaluated.
4	Students will complete an assignment in Chem 151, which will include retrieving information using modern library search tools about a topic, chemical, chemical technique, or an issue relating to chemistry. A graded literature report will be evaluated.
5	A portfolio of laboratory reports in Chem 1LA-B-C (or H2LA-B-C) will be reviewed.

6	A portfolio of laboratory reports in Chem 51LA-B-C (or H52LA-B-C), Chem 107L and Chem 151 will be reviewed.
7	Students will successfully complete an online course on the proper procedures and regulations for safe handling and use of chemicals.
8	Sample experimental reports will be compiled and evaluated. Student presentations will be evaluated.
9	Graduating seniors and alumni will be surveyed and asked whether they were adequately prepared for their careers and whether they were provided with an adequate understanding of their career options.

Grading Rubrics:

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LECTURE-BASED RUBRIC

Criteria	1 Below Expectations	2 Meets Expectations	3 Exceeds Expectations	4 Outstanding
Knowledge of foundational disciplinary areas	Chemical knowledge weak and/or inaccurate; presents information with a limited understanding of the foundational areas of the discipline.	Adequate knowledge of the discipline; demonstrates a solid understanding of the foundational areas of the discipline.	In depth knowledge of the discipline; demonstrates in depth understanding of the foundational areas of the discipline.	Mastering of a broad set of chemical knowledge; ability to synthesize foundational areas within the discipline (e.g., organic, inorganic, analytical, physical, and biological chemistry) with clarity and conciseness.
Problem solving	Limited ability in identifying a problem and in identifying approaches for solving the problem. Evaluation of	Begins to demonstrate the ability to construct a problem statement, and identifies only a single approach	Demonstrates the ability to construct a problem statement and can identify multiple approaches for solving the	Demonstrates the ability to construct a clear and insightful problem statement and identifies multiple

	solutions is superficial and implements the solution in a manner that does not directly address the problem.	for solving the problem. Evaluation of solutions is brief and implements the solution in a manner that addresses the problem statement but ignores relevant contextual factors.	problem. Evaluation of solutions is adequate and implements the solution in a manner that addresses multiple contextual factors of the problem in a surface manner.	approaches for solving the problem. Evaluation of solutions is deep and elegant and implements the solution in a manner that thoroughly addresses it (e.g., rationally estimating the solution to a problem, applying appropriate techniques to arrive at a solution, testing the correctness of the solution, and interpreting results).
Computer and software use	Data acquisition and processing barely based in computer use, and insufficient knowledge of software for data analysis.	Begins to demonstrate skill in computer use in data acquisition and processing, and aware of available software for data analysis.	Competently uses computers in data acquisition and processing, and competently uses available software for data analysis.	Mastered computer use in data acquisition and processing, and thoroughly understands the available software for data analysis.
Information literacy	Retrieves information randomly and from non-library sources; information lacks relevance and quality. The information is fragmented and/or used inappropriately,	Retrieves information using simple, library-based search strategies. Identifies several relevant sources but information is not yet synthesized.	Retrieves information using a variety of library-based search strategies, demonstrating ability to refine search. Communicates, organizes, and synthesizes information from	Knows when there is a need for information and can effectively identify, locate, evaluate, and responsibly use relevant information. Able to use library search

	so the intended purpose is not achieved.		sources so that intended purpose is achieved.	tools to gather information—about a topic, chemical, chemical technique, or an issue relating to chemistry—to fully achieve a specific purpose, with clarity and depth.

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LAB-BASED RUBRIC

Criteria	**Below Expectations**	**Meets Expectations**	**Exceeds Expectations**	**Outstanding**
Experimental methodology	Experimental design demonstrates a misunderstanding of the methodology.	Critical elements of the methodology are missing, incorrectly developed or unfocused.	Critical elements of the methodology are appropriately developed however more subtle elements are ignored or unaccounted for.	All elements of the methodology are skillfully developed and understood (e.g., the objective of the chemical experiments are understood, properly carried out, and results are appropriately recorded and analyzed).
Conducting experiments	Limited ability to conduct experiments; the procedure does not allow control of all variables and stages of the procedure are missing or neglected.	Adequate ability to conduct experiments; the procedure could be more efficiently designed, but it allows for control of all variables and most stages of the procedure are accurate. Replication is modest.	Competently ability to conduct experiments; procedure is well designed and allows for control of all variables. All stages of the procedure are accurate. Replication is appropriate.	Mastered the ability to conduct experiments; procedure is elegantly designed, fully employing laboratory equipment and modern instrumentation in all stages of the procedure. Full understanding of classical techniques to carry out experiments. Replication is robust.
Safe handling and use of chemicals	Limited or no awareness of proper procedures and regulations for safe handling and use of chemicals.	While aware of proper procedures and regulations, there are gaps in knowledge of the topic that	Knows and follows the proper procedures and regulations for safe handling and use of	Discusses in detail and thoroughly abides by proper procedures and regulations for safe handling

		present limited danger.	chemicals.	and use of chemicals.
Communicating through scientific writing	Offers simplistic, undeveloped, or cryptic support for ideas; inappropriate or irrelevant generalizations, faulty assumptions, errors of fact.	Offers some support that may be dubious, too broad or obvious. Details are too general, not interpreted, irrelevant to thesis, or inappropriately repetitive.	Offers solid but less original reasoning. Assumptions are not always recognized or made explicit. Contains some appropriate details or examples.	Substantial, logical, & concrete development of ideas. Assumptions are made explicit. Details are germane, original, and convincingly interpreted.