

Laboratory and Classroom Curriculum Development
Project Proposal

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Abstract

Chemistry is central to a thorough understanding of all sciences. The best possible education in the fundamental areas of modern chemistry is essential to the intellectual foundation of scientists in training. The proposed project has two phases, one of which is to write lab experiments using a guided inquiry approach for General Chemistry I and General Chemistry II courses at Eastern Wyoming College. The experiments will incorporate instrumentation new to EWC, data analysis and graphing programs, accurate record keeping and report writing, and science library literacy. The second phase of the project is to retool the lecture delivery of the basic concepts of chemistry in the classroom. The Chemistry faculty at EWC will explore and expand their knowledge of best practices in chemistry teaching and modern theories of learning and develop materials to implement these methods in the classroom. An online homework database will also be constructed.

Laboratory and Curriculum Development Proposal

I. Description of Proposed Project

Chemistry is central to a thorough understanding of all sciences. It is impossible to understand material science without knowing what atoms are. It is impossible to understand fuel combustion without knowing reaction stoichiometry. It is impossible to calculate flight paths and target trajectories without being able to convert English - metric units or metric - metric units. It is impossible to understand the genetic code of DNA without knowing the unique bonding capabilities of carbon. The best possible education in the fundamental areas of modern chemistry is essential to the intellectual foundation of scientists in training.

A strong General Chemistry program is one that modernizes as the discipline evolves. It also requires chemistry faculty willing to embrace best practices in pedagogy and modern theories of learning. The Chemistry faculty at Eastern Wyoming College recognizes the need to retool the classroom and laboratory delivery of course content. As is true for most community college science faculty, course workload, lab material and chemical inventories, equipment maintenance, and institutional committee responsibilities make it almost impossible to have time for curriculum development during fall and spring semesters. The opportunity to be funded to pursue these endeavors during the summer break is greatly appreciated and provides the only chance to be fairly compensated for time intensive curriculum development tasks.

The proposed project has two phases which are anticipated to be a springboard for development of curriculum in Introductory Chemistry, Organic Chemistry I and II, and collaboration with Biology faculty on student research projects. The first phase involves rejuvenation of the General Chemistry laboratory experience. The second phase encompasses a shift in lecture pedagogy away from a traditional lecture delivery to an interactive student engagement approach including inquiry-based learning, peer-led instruction, and group learning. The goal of the project is to provide a solid foundation for science, technology and engineering students for whom chemistry is a substantial part of their academic path.

Laboratory Rejuvenation Project

The Chemistry faculty at EWC perceives the current student laboratory experience as the weak link in the General Chemistry course. Faculty has been using custom published lab manuals available from publishers. The concept of a custom published lab manual is a good one. Instructors select the experiments they want students to do during the semester and the publisher builds a manual of only those labs. This keeps student cost down by providing a manual of 13 – 15 experiments at a cost of around \$30 instead of a pre-published manual of 50 – 70 experiments costing around \$100. Last fall semester (F'08) in an attempt to refresh lab content, a different publisher was used and the end result was unsatisfactory. The custom manual was a hodge podge of experiments that the publisher put together from multiple manuals. There was no consistency in font size, title presentation, module content, or even page numbering. Some of the modules had pre-labs and post-labs, others had none. Some had detailed “cook-book style” procedure while others had almost no procedure, only data tables. The mish mash of formatting was exasperating to the instructor, but more importantly it was detrimental to student learning. Chemistry can be intimidating to students and the last thing they need is poor communication in the form a slapped together lab manual (that they had to pay for).

I propose to write lab manuals for General Chemistry I and General Chemistry II. The manuals will be tailored to enhance lecture content, use available equipment and chemicals, and be adaptable to future curriculum changes. One can look through a seemingly endless list of labs available for custom publish and find a module that has desired content, but finding one that matches equipment availability, pedagogy of engagement, and supplemental information preferred by an instructor is a rarity. All pre-published labs need adapting to fit a specific lab environment and faculty often use 20 – 30 minutes of precious lab time instructing students on modified procedure. Instructor authored manuals would eliminate the need for pre-instructions and allow students valuable time to conduct experiments and analyze data.

Many published lab manuals or modules employ what I call “cook book style” procedure. While it’s important to give first year chemistry students guidance, many manuals go beyond guidance. For example, students are often instructed on exactly what size beaker to use (a 150 mL instead of a small) or how many decimal places to record from a balance. In my opinion, this impedes a student’s development of planning and decision making skills. Professional scientists don’t have a “cook book” to tell them what glassware to use, how to record significant figures, or what step comes next. Instructor authored labs will be inquiry based and students will learn to decide for themselves what glassware to use and how to read measuring devices. These concepts will be reinforced each week. Manuals can also be easily edited to adjust for the every changing needs and skill levels of the student population.

When appropriate, instrumentation will be incorporated into lab experiments. Over the last few years the EWC Chemistry and Biology departments have been acquiring Pasco PasPort hand held dataloggers that have interchangeable probes for spectrometry, pH, drop counters for titration curves, temperature, and many biology and physics probes. The dataloggers come with analysis and graphing software that interfaces with classroom computers. While I feel it is vital for students to learn data acquisition and graphing by hand on paper, software literacy for these functions is equally vital. I plan to attend a “Chemistry with Probeware” summer institute sponsored by Pasco at their headquarters in Roseville, CA in mid July.

Students will be required to keep a laboratory notebook and write a lab report. Critical skills of any scientist are keeping accurate records and communicating information. Initial guidance will be given to first semester, General Chemistry I, students in the form of objectives, data tables, sample equations, and questions leading towards viable conclusions. By the end of second semester, General Chemistry II, students will be writing their own objectives, designing data tables and graphs, and drawing conclusions with little or no assistance. Such skills will enhance student transferability to four year institutions in the areas of science, technology, engineering, and undergraduate research positions.

In addition, a library literacy component will be incorporated into the lab experience. It is very important for students pursuing careers in science, technology, and engineering to retrieve and use scientific literature effectively and to evaluate technical articles critically. EWC has limited on site resources but in recent years subscriptions have been purchased giving access to a wide range of scientific literature resources. EWC’s librarian, Marilyn Miller, will be assisting me to effectively incorporate the library literacy component.

Using previously self-authored lab experiments as a gauge, I expect to spend 4 – 8 hours drawing together background information, content, data tables, and guided inquiry questions for each lab. In addition, a dry run, and possibly an actual performance, of the experiments

will be conducted at the EWC chemistry lab. Each manual (one for each semester of General Chemistry) will have 13 – 50 lab experiments and laboratory safety guidelines.

In conjunction with the manuals themselves, an instructor's guide will also be written. Its primary purpose will be to provide guidance for work study students employed in the Chemistry Department. A secondary purpose will be to assist the absent minded professor.

Lecture Retooling

A few years ago the use of PowerPoint lecture slides was encouraged by EWC administration as a way to introduce technology into the classroom. Many hours were spent designing slides for each chapter and while the slides are useful for delivering quantity of content, I don't believe they've enhanced quality of content delivery. I've tried giving students copies of the actual slides and fill in the blank copies, both with the same result – boredom of all (including the instructor). During the spring semester (S'09) I went back to the old fashioned chalkboard lecture technique. One tired arm, truckload of chalk dust, and semester later, I had experienced the most interactive and enjoyable General Chemistry II class in a long time. Another attempt at integrating technology into the classroom has been to use computerized homework assignments made available by publishers. While I embraced not having to grade handwritten homework assignments, my students haven't done well with being graded just on their input answers alone. Problem solving is a process, a series of steps, and the minor step is inputting an answer. Students need instructor feedback on what they are doing incorrectly **and** what they are doing correctly. Computerized homework only presents one solution process and even though a student may solve the problem correctly, they believe they did it wrong because their solution method doesn't match the computers method. This undermines a student's confidence in their problem solving skills.

To increase classroom participation I plan to continue chalkboard chemistry lectures. In addition, I propose to develop worksheets and guided-inquiries to be done in class, both individually and in groups, to reinforce concepts covered in that day's lecture.

A more time consuming proposal is to develop my own version of online homework. Students will purchase a notebook that will do carbonless copies and have numbered pages. They will logon to Blackboard and access a chapter's homework question bank from the course homepage, write their solutions in the homework notebook, and enter their answers on Blackboard for immediate answer feedback. They will turn in the carbonless copy of their written work to the instructor for solution process review. Corrections will be made, and the copy returned to the student who will be able to compare their original problem solving method to the corrected one. Students will be receive credit for the number of correct answers input through Blackboard but the major credit value will be assigned to their written solutions. Developing the homework question bank will be time intensive, but once in place it will be easy to implement.

A library literacy component will also be incorporated into the lecture. I anticipate that the lab and lecture library literacy projects each week will be the same project rather than two separate projects.

Summary

The Chemistry faculty at Eastern Wyoming College desires to provide a high-quality chemistry education to students in all career paths with special attention those in science, technology, and engineering. This quality education encompasses coursework in basic

chemical concepts and laboratory experiences that promote independent and group thinking, critical thinking and reasoning, and the perspective of science as a process of inquiry. Realization of this desire is time intensive in the preparation of lab and lecture materials and can only be satisfactorily accomplished during summer break when time is available.

II. Relationship to Space Grant and NASA Goals

The goal of this project is to provide a strong educational foundation in chemistry for students pursuing careers in science, technology, and engineering. It is essential that the chemistry program at EWC adapt to the ever changing needs of its student population in learning style and level of preparedness for college. The training of America's future professional scientists begins with their first college science course. Students must be well trained in the scientific method, record keeping, and result reporting in their first college science lab experience. A dynamic, well planned, and well implemented chemistry classroom will attract and retain students in science classrooms as well as motivate them to pursue science careers.

III. Products

General Chemistry I and General Chemistry II lab manuals (13 – 15 experiments per manual).

Homework database to be uploaded to Blackboard.

Guided-inquiry projects for the lecture classroom.

Collaboration with Biology faculty on a student research project to be used as a program capstone.

Project proposal to write Organic Chemistry I and II lab manuals.

Project proposal to write Introductory Chemistry lab manual and implement guided inquiry in the lecture classroom.

IV. Timeline

General Chemistry I lab manual, homework database, and guided inquiry projects ready for the start of the Fall 2009 semester.

General Chemistry II lab manual, homework database, and guided inquiry projects ready for the start of the Spring 2010 semester.

V. References

ACS Guidelines for Chemistry in Two-Year College Programs, 2009. American Chemical Society, Committee on Education, Washington, D.C.

Budget

This proposal requests salary compensation in the amount of \$10,000 for Dr. Lorna Stickel, Chemistry Professor at Eastern Wyoming College (current monthly salary \$5472.37). It is anticipated that writing and testing of the lab manuals will take 4 – 5 weeks (40 hrs/week) and classroom lecture materials and homework database will take an additional 1 – 2 weeks. Non-federal cost share amounts provided by Eastern Wyoming College include: \$200 labor for Marilyn Miller, the EWC library director, who volunteered to assist with the library literacy project; \$700 supplies for software program upgrades, lab material and equipment used for review of experimental procedures, and use of EWC lab facilities; \$1500 for travel to Pasco summer institute July 15 and 16, 2009 - \$400 registration, \$400 hotel, \$700 airfare and car rental.