Instructor Name: K. Joseph Ho

Department: Chemistry

Course: CHEM 1215L/1225L, General Chemistry I & II for STEM Majors

ECURE Engagement Level: PARTIAL

Description of PARTIAL implementation: Gathering background knowledge: The background reading assignment consists of literature reading that students must complete before coming to the design lab. The background reading explains the scenario of each experiment (project) and related chemistry principles students need to understand for designing the experiment. This assignment serves the purpose of a literature search for a typical research practice.

Writing hypothesis: students construct a hypothesis for the research question after Background reading for a grade. This assignment is an assessment of students' comprehension of the background reading and the ability to construct a measurable hypothesis using deductive reasoning.

Designing experiment: students design experiments collaboratively through discussions of guided questions and carry out procedure testing to confirm the feasibility of their procedure. Students are provided with examples of protocols for common experimental techniques as videos or written procedures.

Collecting evidence: students carry out their own procedure collaboratively and generate useful data for making conclusions about the lab questions using scientific arguments. During the procedure, students also face unexpected problems that require them to find alternative or revised steps from their original plan. This is good training for problem-solving skills.

Failure & Iterations: students practice problem-solving during experiments and master their lab techniques with iteration and replications; students are allowed ample of time to accomplish the experiment. If they do not have time to repeat the procedure, they are asked to provide reflection in their post-lab report.

Communicating scientific ideas: Students brain-storm design ideas in small groups, practice presenting scientific arguments to the class, and write lab reports with the required format.

Practicing lab ethics: students wear PPE and proper dress code to protect themselves and other people in the lab; students use preventive measures to prepare themselves for chemical accidents. Students also consciously avoid copying others' reports or quoting sentences without proper citation.

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The only element of research this course does not fully explore is the novelty of the outcomes, which disqualifies this course from being classified as ""Full"" CURE. To make students' work original, proper design of the lab scenarios is required. With limited knowledge in the field freshman students have developed and the restriction of lab equipment and safety concerns, it is a challenge to find proper scenarios for producing novelty of outcomes at the freshman level. Nevertheless, if you plan for CURE in upper-divisional courses, it is a reasonable task for a FULL implementation of CURE at this level.

Examples of Novelty of Outcomes: having students design and carry out the synthesis of new chemical compounds with a newly published method; having students conduct new surveys by replicating a published survey; having students design new products based on the current demands; etc.

Assessment:

Pre- (week 1) and post-tests (week 16) of lab concept inventory. The concept gains between the pre- and post-tests are calculated as a measure of students' concept learning.

Skill Assessments - to assess student's lab techniques by asking each student to demonstrate the selected techniques in front of the instructor and assign a grade with a rubric

Practical exam - a comprehensive practical test with 5 stations in the lab. Students answer questions from each station by designing a 5-10 minute experiment, analyzing data, and making conclusions by using scientific argumentation. This test reflects students' research skills.

Lab reports writing - assessing students' written communication skills

Presentation - each student is evaluated on their oral communication skill by giving a 5-minute presentation on selected topics.

Weekly quizzes - the quizzes evaluate students' preparation of the experiment and understanding of the background information required for the design of the experiment and analysis of data.

Engagement with Academic Literature:

We engage students in literature reading by giving them Background reading assignments before starting each project (experiment). The reading assignments were specifically written at the freshman level so that they could understand the reading. This is crucial because if they cannot understand the information, they will be disengaged. In the reading assignments, we mixed the original text from the research literature with laymen's explanations to guide them into the more complex literature in the future.

We engage students in literature again during our design lab discussions with guided questions. This provides more scaffoldings for doing independent literature searches by students.

Students revisit literature when they make scientific arguments from the experimental data. This practice helps students learn to recognize the key concepts or approaches for the experiment (or project) and the development of hypothesis based on the same principles.

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Additional Information: It takes many trials and errors to find the best effective approach to your ECURE. Getting fast feedback from your students and carefully monitoring students' performance is crucial for quick refinements of your program. It is always helpful to get students' buy in at the beginning of the semester, and sometimes, the student buy-in takes many semesters to reach fruition.

Instructor contact information: khoj@unm.edu

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