

ALIGNING ACTIVE LEARNING AND REAL-WORLD APPLICATION IN CHEM 635: INSTRUMENTAL ANALYSIS

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Background

I am teaching Instrumental Analysis (CHEM 635), which undergraduate Chemistry majors take during their junior or senior years. It is the second course in the Analytical Chemistry series, and it usually draws 15-20 students. The primary course objectives are for students to 1. recognize and describe the major components of analytical instruments, 2. convey ideas related to analytical theory, instrumentation, data analysis and applications, and 3. evaluate analytical methods and data in original research articles.

Issues to address

I have taught this course only once – during Spring 2020. It was my first semester of teaching, and I approached the class with a traditional lecture/problem set/exam format. I incorporated some active learning questions and activities into my lectures. When we moved online halfway through the semester, I transitioned to an asynchronous class with recorded lectures. In this format, it was harder to include active learning strategies.

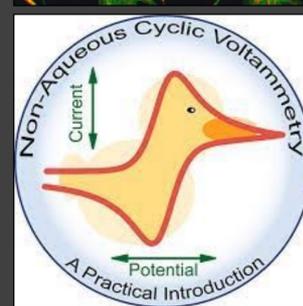
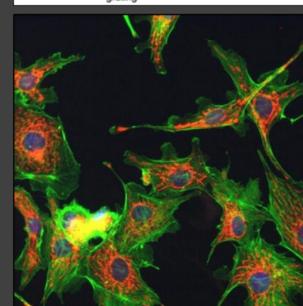
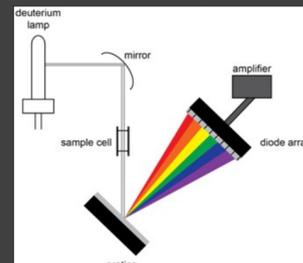
I had several goals for the course transformation:

1. Focus on topics that extend and complement what is covered in the first semester of Analytical Chemistry (CHEM 400).
2. Incorporate more learning activities as a regular component of the course.
3. Align assessments with course goals by focusing on problem sets with more “real-world” problems that include designing analytical experiments and reading original research articles.

Implementation

To achieve the three goals, I adopted several strategies:

1. I added pre-quizzes that are taken on Blackboard prior to starting the week. The pre-quizzes cover material that students should have learned in previous classes. The goal is to show mastery of the topic, so the students can re-take each pre-quiz up to 10 times. Instructional refresher videos and suggested readings are provided in case students need to review a topic. The pre-quiz strategy allows me to spend course time on topics that are new to the students.
2. My general plan for the class was to lecture on Monday and provide an in-class activity on Wednesday. For the in-class activity, I experimented with introducing new topics through worksheets and facilitating small group discussions. I also invited several guest experts in certain instrumental topics to help diversify the class experience.
3. Since I have students who are taking the course online, I wanted to eliminate in-person exams. Students will complete six problem sets that are more challenging than the calculation-based problem sets that I used last year. My goal has been to make the problem sets more reflective of activities they might do as scientists in the future. For example, I ask them to design simple experiments, to read and answer questions about original research articles, and to access various internet resources useful in planning experiments and understanding analytical instrumentation. The final exam will be a take-home exam in a format similar to the problem sets.



Student learning

1. Pre-quizzes: Since basics were covered in the pre-quiz material, I was able to focus my lectures and in-class activities on new material. This strategy gave me more flexibility during class and created more time for active learning during class. However, I did not anticipate one aspect of the pre-quiz logistics. Initially, I allowed students to take the quizzes (administered on Blackboard) as many times as they wanted. After each quiz, they were told their score (out of 10), but not which questions were incorrect. This led to a few students taking the exam many times, but only answering one question to figure out which question was wrong and which answer was correct. Ideally the students would be engaging with the material to figure out the answer rather than “gaming” the quiz. Eventually, I limited the number of attempts to 10, but this felt like it only partially addressed the problem.
2. In-class activities: I have not been as creative with the in-class activities as I had hoped. Mostly, I prepared worksheets that students worked on individually and then we completed them together. I have had a few group work/discussion activities that went well. We have also had a few guest speakers for the in-class activity session, and I think this has been more successful and expanded student's learning and awareness of research on campus.
3. Problem sets: I have written new problem sets for this semester that have asked students to design experiments, read literature, and interpret or compare instrumentation, methods, and data. I think I have been successful in having students attempt more “real-world” types of questions and problems. My hope is that they are learning more from this type of problem set.

Reflections

Challenges persist from COVID-related restrictions. I have been teaching in a hybrid format with 5-8 students live on Zoom and 12-15 students in person. The technical challenges of this format required a lot more effort from me to make sure everyone could see everything and hear everything. I also felt that masks made it more difficult to connect with students. Finally, it felt like everyone was burnt out by an early point in the semester. The lack of Spring Break was tough on everyone.

In general, I think the changes I made helped me make progress toward my goals. By adding in the pre-quizzes, I was able to focus the class more on new material. In the future, I think I will adjust the quizzes in some way. One option is to keep them on Blackboard (or Canvas) but provide feedback (which questions are incorrect) and only allow a few attempts. A second option would be to move the quizzes to in-person; with this option, I would make the quizzes shorter and easier.

Splitting the week into one lecture day and one activity day format worked well, and in the future, I would work to improve the activities to include more interaction and active learning. This will also be easier in a post-COVID, non-hybrid format. Finally, I really liked having more challenging problem sets instead of in-class exams. Although I made this change to accommodate the hybrid format, I plan to continue using this type of problem set and overall approach in the future.

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