Spring 5-1-2020

Pedagogical Approaches to Enhance Q2S Conversion Teaching and Learning: Application of the ACUE Effective Practice Framework to Upper Division Biochemistry

Jason Burke
jason.burke@csusb.edu

Pedagogical Approaches to Enhance Q2S Conversion Teaching and Learning: Application of the ACUE Effective Practice Framework to Upper Division Biochemistry

Jason R. Burke, PhD
Assistant Professor of Chemistry and Biochemistry
California State University San Bernardino
May 1st 2020

Abstract

The Effective Practice Framework course by the Association of College and University Educators (ACUE), and offered through the CSUSB Teaching Resource Center (TRC), was applied to the upper division biochemistry course series (CHEM 436A and 437A) in preparation for the Q2S conversion. This essay includes five reflections on the application of enhanced pedagogical approaches curated from a total of twenty-five. The enhanced pedagogies covered in the course are: designing and effective course and class; establishing a productive learning environment; using active learning techniques; promoting higher-order thinking; and assessing to inform instruction and promote learning. The reflections that follow have been selected to represent a broad sampling, illustrating the application of diverse objectives for enhancing teaching and learning at the Q2S conversion.

Key words: Q2S, TRC, ACUE, Effective Practice Framework, Biochemistry, CHEM 436A, CHEM 437A, CHEM 4100, CHEM 4200

Introduction

The Effective Practice Framework course, offered by the Association of College and University Educators (ACUE), was used to enhance instruction for an upper division biochemistry course series; consisting of introduction to biochemistry, covering the structure and function of biomolecules (CHEM 436A), and the biochemistry of metabolism (CHEM 437A). The categories of enhanced pedagogies that are part of this ACUE course include: designing and effective course and class; establishing a productive learning environment; using active learning techniques; promoting higher-order thinking; and assessing to inform instruction and promote learning. This work includes five reflections of adaptations, one from each of the pedagogical categories. These reflections on enhancing pedagogies are curated from a total of twenty-five reflections that were completed during the course, and are selected here to represent a diverse sampling that illustrates the application of various approaches for enhancing teaching and learning to biochemistry. Application of the approaches had the demonstrated effects of: improved participation, increased active learning, more transparent assessment, and importantly, (during the Covid-19 outbreak) adaptation to an online learning format.

Reflection #1: Assessing to Inform Instruction and Promote Learning

The learning module on assessing to inform instruction and promote learning afforded the opportunity to "*Develop Fair, Consistent, and Transparent Grading Practices"* by implementing the technique: "*Use continuous assessment practices in online courses*". I chose this technique because I've been searching for a thoughtful way to implement assessment for an online course in a way that students, who are new to online learning, can easily understand. To implement this technique, I started using several of the guidelines in a "*Continuous Assessment Practices for Online Learning"* handout, which I've found to be suitable for the content of the weekly learning modules. Specifically, I'm dividing high value assessments into medium value assessments by weighting points away from three exams to weekly homework assignments. Additionally, the learning modules for each week are designed to have approximately the same point values, spread across 2-3 assignments, to ensure a relatively even distribution of points throughout the duration of the course.

Successes and challenges have been encountered. By surveying the students about their impressions of the class so far, I've come upon one unforeseen challenge, which is that quite a few of them are concerned about the shift to more numerous medium value assessments, and away from few high value assessments (these students are used to 2-4 high value assessments, the true-blue standard for natural science courses). On the other hand, just as many if not more students seem optimistic about continuous assessment. I get the impression that the students who favor it may think it's easier, even though I've told them that it's the same material, the only difference is that they are simply "spreading out" their effort. Nevertheless, maybe they think it's easier because its less stressful? And maybe it is, in fact, an easier way to learn? Whatever the case, due to the current circumstances (Covid-19) I've designed my class this quarter with less concern for ensuring academic rigor and performance, and a greater focus on incentivizing consistent engagement with the material. One challenge going forward will be to find out: is this type of course structure still feasible when we move back to a more traditional model for natural science courses, in which relativistic academic performance is a more central focus of course design?

Plans for the refinement of this technique are being developed. In the future, one way to maintain the thrust of what I'm creating here, while placing more due emphasis back on performance is to *align the value of the assessment with cognitive challenge*. Currently I don't use online quizzes, but weekly, more heavily-weighted timed quizzes would help to sift through the gradient of large classes. As for sharing grading policies with students, this time around I've made a video of how to do the homework, as well as check to see which answers are right and wrong, and make a second attempt for a better grade. These rules for assessment in the form of a "video syllabus" seems like a high value practice that I've stumbled upon this quarter, and which I will continue to modify to include changes as they are made to assessment protocols.

Reflection #2: Promoting Higher Order Thinking

The learning module on promoting higher order thinking provided the opportunity to *"Integrate visual tools in class sessions or online presentations*". I chose this technique because I'm teaching a course on metabolism, and a *concept map* is a great way to connect different metabolic pathways to each other. Even though the pathways are taught as different learning modules, there is an important connectivity that leads to unified functionality; a concept map reinforces this. I implement this technique by including a diagram of metabolism (depicted as a subway map) at the introduction of each pathway (learning module). I then use the subway metabolism map to explain the importance of each metabolic pathway and its relationship to other pathways that we have already learned about, or have yet to learn about.

Successes and challenges have been encountered. In teaching an entirely online course with an asynchronous format (to increase accessibility specifically for this quarter S2020), I'm finding that it's nearly impossible to gauge student feedback in the ways that I'm used to in the in-person classroom. Therefore, one main challenge is to determine how well any new technique is actually working. One key success is that I have used this strategy in the past, but not as effectively. In preparing the educational material to be online, I've actually increased the number of times that I use the central metabolic concept map, as well as the time that I spend using it for concept review. I'm not sure yet, about its efficacy for students in reinforcing and enhancing learning, but I think it's a success for me in terms of widening the scope and utility of the educational material for this course.

Plans for the refinement of this technique are being developed. As with many things I'm doing differently in this online learning quarter, I would like to know if students find this useful. To do this, I'm planning to deploy a blackboard survey that will include these questions as part of the survey: *Do you find the presentation and description of the metabolism subway map useful?* They can answer: highly useful, useful, not very useful. An open-ended follow-up question will ask: *Is there a way that the use of metabolism subway map can be improved?* I will use this feedback to modify and refine how this concept map is used to introduce, explore and define metabolism.

Reflection #3: Using Active Learning Techniques

The learning module on using active learning techniques provided the opportunity to *Design lessons aligned with the Active Learning Cycle (concept exploration, concept introduction, concept application)*. The reason I selected this technique is because the breakdown of the active learning cycle seemed amenable to apply directly to a central active learning activity that we

cover in my large introduction to biochemistry class: *A case study of the enzyme mechanism of chymotrypsin*. To implement, I altered the active learning exercise to fit the learning cycle. For the *concept exploration* phase, the leading exploratory question of the exercise was adapted to a multiple-choice format: *Which type of enzyme inhibitor is DIFP? A) competitive; B) uncompetitive; C) noncompetitive; D) irreversible?* The second question in this phase is more of an intellectual reach, and touched on the idea that serine can act as a nucleophile in an enzymatic reaction (a topic not explicitly covered, yet deducible based on principles). Next, in the *concept introduction* phase, we expanded upon our foundational knowledge of protein structure and intermolecular forces (covered extensively in previous chapters), in order to understand how structure can be used to inform enzyme function, specifically in this context: proposing an enzyme mechanism. Finally, with *opportunities to apply knowledge*, students were asked to propose each step of the relatively long and complex enzyme mechanism for chymotrypsin, from beginning to end, using information from the case study experiments (such as DIFP inhibition and the protein structure). This application of knowledge in this final phase increased accountability because recollection and application of the previous material was required for this final *synthesis* stage of this learning cycle.

Successes and challenges were encountered, but mostly the application of these strategies created improvements when compared with previous times that this exercise has been used. The multiple-choice question in *concept exploration*, primed their memory of each of the concepts we had covered in the previous lecture. Rather than an open-ended question, requiring them to draw the answer from thin air (previously used), the multiple-choice question forced an explicit comparison between the different concepts that were listed as possible answers; each comparison made to the data provided. This was conclusively a thoughtful improvement on the early phase of the exercise. Overall, I added many additional opportunities to apply knowledge, and really changed the exercise to be entirely student discussion-driven, rather than instructor-led. This resulted in the exercise taking twice as long (previously we completed it in a single lecture period; this time we barely finished in two). But it is difficult material, some of the most difficult that we cover in this course, and a rare, golden opportunity to apply just about all of the knowledge from the course (up to this point) to just one system. The fact that students came up with all of the correct rationale for each step of the mechanism assured me that some students walked out of that class period with a mastery of each step. In addition, I feel like their momentum in using facts to apply reason to the problem increased throughout the exercise, and ultimately the students gained a solid foothold in understanding how to apply *scientific rationale*. Enzyme mechanisms are a notoriously challenging application of chemical knowledge, which must be gained from years of rigorous course work. By using this approach, students gained a foundational understanding, in which they, themselves, answered all the *why and how* questions. This strategy, once mastered, can be easily applied to just about any other enzyme mechanism. It was a remarkable set of improvements to an active learning exercise that has been a labor of love for this instructor.

Plans for the refinement of this technique are being developed. Now that I know that it takes two full class periods to conduct this exercise effectively, I will plan to have a smoother transition between the two periods. Specifically, rather than providing a short review of the first session before jumping into the second (which is what I did this time), I will have the students answer key questions and fill in the blanks as we review the material at the beginning of the second session.

Reflection #4: Establishing a Productive Learning Environment

The learning module on establishing a productive learning environment afforded the opportunity to "*reflect on your how well your behaviors model classroom civility"*. I chose this reflection because it provided a structured and goal-oriented opportunity to evaluate how my behavior contributes to the environment that I create in the classroom. In reflecting on my own behaviors in leading the classroom, this module helped me highlight behaviors that, 1) I should strive to keep up and perhaps even implement more often, and 2) behaviors that could use improvement. To begin, one behavior that I often use is to regularly ask for student feedback. I do this by having students anonymously submit "questions, comments or concerns" on 3x5 inch cards at the end of a specific class period, usually around week 4-5, just after the first midterm exam. The feedback is often useful, and I change my behaviors to accommodate student requests (i.e. provide more in-class problems similar to the exams, post notes online, hold extra study sessions or office hours before the exams). While this is useful, I need a way to solicit informal feedback more frequently. A second behavior that I may need to work on is: *students see me as the authority figure in the classroom*. I am only in my second year as an assistant professor, so I believe that I come across as less "seasoned" and perhaps less confident as well, than people who have been doing this longer. I recently had a challenging student who started to take advantage of the fact that I highly encourage informal question asking during lecture (as a strategy to stimulate conversation and build applied context). This particular student, on two separate occasions, blurted out comments outside of the context of the lesson that were insubstantial and essentially *pot shots* at me. I think *establishing authority* may come with time, in the course of a natural evolution of how I conduct myself before the class. On the other hand, I like to think that I actively try to make myself seem open to students, and I even fret that I might seem too intimidating to them at first. I suppose that, if the rare student interprets my openness to be a vulnerability, then maybe it's just an occupational hazard that comes with the free and fair learning environment that I try to create.

The impact of instructor behavior on students has been observed. As far as how *establishing authority* impacts student behaviors, I believe that there is a direct relationship between authority and approachability; appropriately balancing these two things contributes to success in an active learning classroom environment. When students see me as more of a *guide* for the material, whose role is to help them understand, as opposed to seeing me as a future evaluator who is telling them a list of specific things to learn, then I see their behaviors shift toward being more engaged and interactive. As for *asking for student feedback*, students are always very grateful for this opportunity. Even when they have no specific constructive feedback to offer, I believe that this practice makes them feel that I care about their learning and needs by simply offering to consider their opinions.

Moving forward, I have made a list of steps I can take to increase the frequency of beneficial behaviors that affect the classroom. First, I will implement post-midterm surveys which ask students if they did better, the same, or worse than expected, and what might help them to do better. In order to encourage participation in the survey, I'll have it be worth a couple points back toward their test grade. Second, I really like the 3x5 card exercise that I already use, but I think that some students need more time to think about it, in order to come up with constructive feedback. So, to increase the frequency and quality of this behavior, I'll introduce the idea of the card exercise in the class period before it is implemented, and implement it more

than once during the semester. This way they will have more time and opportunities to provide high value course feedback.

Reflection #5: Designing an Effective Course and Class

The learning module on establishing a productive learning environment afforded the opportunity to "*strategically integrate active learning techniques"*. First, to understand why I chose this technique, it's important to note that the chosen lecture topic (which is foundational to the lecture material and therefore necessary), students have unfortunately found to be rather boring (myself included, also unfortunately). Therefore, my primary motivation was to engage students. However, this active learning exercise ended up deepening understanding of the material for students (and myself) in ways that I never expected.

This is how I implemented the active learning technique, which was a *demonstration*: I had a student volunteer come to the front of the class and physically behave as though he were an enzyme whose function it is to break a yard stick. The class was then prompted with questions (by me) to draw connections between the parameters of the enzyme reaction diagram (displayed on the projector) and the behavior of the student in front of the class who could make various physical manipulations to the stick. I selected this technique because it is based on an analogy given in the text book, which I find instructive to read. However, rather than simply presenting the book's analogy to the students, it occurred to me it would be much more fun to have a student physically demonstrate the analogy of an enzyme mechanism, by stick breaking (or attempting to do so).

Successes and challenges have been encountered. Based on the classroom engagement during the demonstration (a greater number of questions, comments, chatter, laughter, etc.) relative to previous times when I have given the lecture without this demonstration, it was a great success in engaging students. Furthermore, through various physical scenarios (which the students' themselves envisioned) of how to best break a stick (i.e. use the knee to increase intermolecular forces near the enzyme transition state), vs. keep a stick from breaking (i.e. hold it against one's body to stabilize binding away from the transition state), we were able to visually and physically explore a suite of illustrative hypotheticals. Therefore, in addition to greater student engagement, the depth of learning was enhanced and the material was made to be more memorable through this active learning demonstration.

Plans for the refinement of this technique are being developed. In the future, the demonstration will be refined to enhance the participation of other students. Rather than using a single student for the demonstration, I will have multiple students take turns presenting poses to represent reaction progress and various hypotheticals related to the enzyme reaction diagram.