



Lesson Study: Exploring Students' Understanding of Acid/Base Buffers in a Laboratory Setting

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The Problem:

- The experiment was overly complicated, which prevented students from focusing on the learning goals.
- We have always observed a disconnect between the calculations the students perform in lab and lecture and the practical aspect of using a buffer.

Learning Objectives:

Upon completion of this experiment, students should:

1. Explain the following concepts:
 - a. What a buffer is and what its uses are.
 - b. How to select a buffer system given a target pH value.
 - c. How buffers resist changes in pH upon addition of acid or base.
 - d. The relationship between K_a , pK_a and the Henderson-Hasselbach equation.
2. Perform the following skills:
 - a. Prepare a buffer solution.
 - b. Use the Henderson-Hasselbach equation.
 - c. Apply ICE and BCA tables appropriately.

The Lesson:

Students come to class having read through the experiment in the lab manual and having watched a video demonstration of making a buffer. This video is accessible through D2L.

A brief pre-lab lecture is given where the lab instructor highlights important information for the experiment and also walks through example calculations for working out the pH of solutions similar to those the students will be making in the lab.

The students must then determine the quantities of reagents they need to make their assigned buffer solution, take a portion of that solution and dilute it to make a dilute version of their buffer and then test these buffer solutions with strong acid and strong base.

Students then determine the pH of their various solutions using the method shown to them in the example calculations.

The Study:

Observations were collected by two instructors in the lab who walked around and listened to the students in their discussions with each other and the instructor.

Pre- and post-lab quizzes were designed to assess each student's level of knowledge about buffer selection, preparation and strength. These were administered before and after the experiment was performed.

Conclusions:

As a result of this lesson study, we noted more independent work from the students than we had seen in previous sections and a decrease in questions related to the procedure and necessary calculations. This would imply that the students had a greater level of confidence coming into lab.

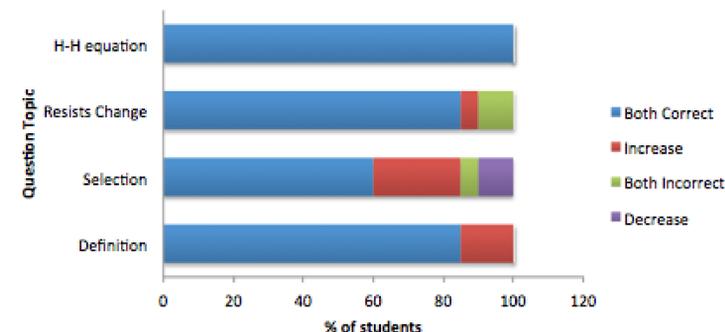
However, the performance from the assessment indicates that there is still a disconnect between the conceptual ideas/learning goals of this experiment and the practical aspects of preparing a buffer and performing relevant calculations. As a result, more work should be done to highlight the important learning goals for this experiment.

Recommendations:

The department's laboratory manual should incorporate the updated procedure and data sheets used in this study. There should also be an effort made to provide a short introduction to buffers, specifically related to the learning goals for this experiment. Laboratory instructors should also try to highlight the learning goals at the beginning of the experiment, prior to the example calculation, to help students relate the theoretical and practical aspects of buffer systems.

We have also incorporated organized questions at the end of the experiment to assess students' understanding of the core concepts and learning goals outlined in this lesson study. Students will explain how buffer strength and resistance to pH is connected to concentration and also explore what components are needed to prepare a buffer.

Pre- and Post-Quiz Question Analysis (Fall 2014)



Pre- and Post-Quiz Question Analysis (Spring 2015)

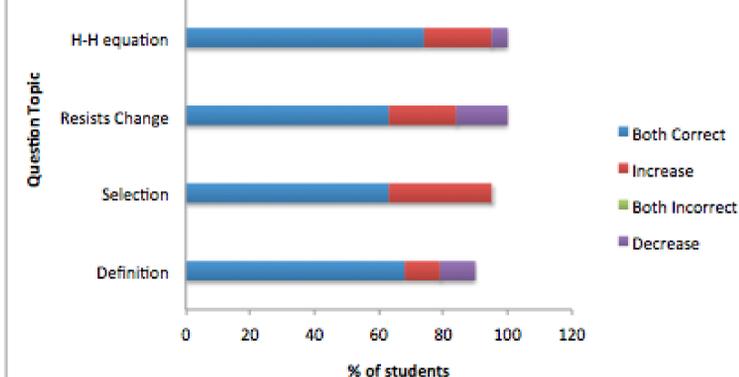


Figure 1: Changes in Pre/Post Lab Assessment in Observed Sessions



Figure 2: Screenshot from the D2L video on making the buffer.