In Spring of 2017 I tested out 4 additional Labster Virtual Labs and retested the impact of the Enzyme Kinetics Lab on student learning. This semester I split the students into two groups again but did not give the two groups different assignments as I had in Fall 2016. This semester I was mostly concerned with ensuring that using the same assessment items on subsequent quizzes was not artificially increasing student performance simply because they were retaking the same exams. I was also interested in isolating the effects of the Labster Labs from other learning that may have been going on during the semester so I tried to encourage the students to take the pre-test, complete the Labster Lab, and then take the post-test in as short a time as possible. Students were given access to the labs and asked to complete a pre-test (Pre), then the appropriate Labster Lab (Protein Denaturation, Protein Synthesis, Enzyme Kinetics, Carbohydrates, or Cellular Respiration), and then finally a post-test (Post). For each series of assessment and Labs there were some students that failed to complete the Labster lab in-between the two assessments. The responses of these students served as a negative (i.e. “no Lab”) control because they did not complete the Labster Lab between the two and any improvement in performance they might have can be assumed to coming from everything else besides the Virtual Lab. All assessments except for the Carbohydrate assessment had a randomized order of questions to prevent students from memorizing the answers to questions from the pre-test when they take the post-test. In each plot below the “No Lab” controls are shown as empty columns (these are only shown in cases where a significant difference was found between the pre- and post-test assessments for the associated set of questions), pre-test results are lighter colored and post-test results are darker. Performance on different classes of questions are sorted by color: recall questions (red), applied questions (green), ACS questions (grey), ACS 2007 questions (blue) are shown for each module being assessed. For some of the modules (Protein Synthesis and Protein Denaturation) there was not very good overlap between the ACS questions or textbook questions and the content being covered in the Labster Virtual Lab. The p-values for the Student’s t-test for significance is given for experimental datasets above the respective columns being compared and for control (“No lab”) datasets below the respective columns being compared.
Neither the Protein Denaturation nor the Protein Synthesis Labs showed a significant impact on student learning. This is likely because there were not really too many well-aligned questions in the assessment question banks for these modules. In the future, it will be necessary to achieve better alignment between the activity, the assessment tools, and the learning objectives of the course or perhaps create new assessment tools which properly align with both the virtual lab and the course content. This will take more time and energy on my part.
In the case of the Enzyme Kinetics Module, the results from Spring 2017 supported the conclusions from the previous semester. Student did significantly better on Applied and ACS-style questions when they used the Labster Labs in all but the recall-type questions. Also it was apparent that duplication of the questions on the pre and post-test does have a significant effect on recall-type questions even when questions are randomized between quizzes (p=.008 for the recall questions without the lab performed).
In the case of the Carbohydrates virtual lab module and assessments I actually forgot to randomize the quiz questions and it appears the students were very easily able to remember the questions from the pre and post-test so even the no-lab control saw a very significant increase in their performance on the assessments across the panel of question types.

In the Cellular Respiration Lab, assessment questions were somewhat aligned to the virtual-lab (although better alignment would certainly be nice) module and the assessments were randomized so the “No lab” control populations did not seem to be capable to remembering answers from their prior attempts on the quiz. The effects of the virtual lab module were only moderately significant as indicate by only a slight increase in the post-test data for each question class relative to the other data for the same question class.