Activity Summary

The Enzyme Kinetics activity was taught during the summer of 2017 as part of the Maximizing Access to Research Careers (MARC) Summer Research Institute (SRI) program, which belongs to one of the STEM Diversity Programs at UCSC. The activity consisted of a 2-day intensive class and lab activity that gathered 12 learners.

Learners used the concept of enzyme kinetics to investigate how an enzyme interacts with different substrates and determine which substrate works the most efficiently. Some of the key concepts learners learned were:

- Identify that the Michaelis-Menten plot has units of uM vs (uMproduct/sec OR uM vs (molproduct/sec)/molenzyme.
- Describe the key portions of an enzymatic reaction using the Michaelis-Menten graph.
- Understand that catalytic efficiency is the best way to compare enzymes.
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Learners were expected to explore the concepts outlined above and engage in the practice of explaining results and/or solutions based on evidence through the following dimensions:

- Making a claim
- Choosing proper evidence to support the claim
- Connecting the evidence to the claim through reasoning.

Being able to create and analyze a Michaelis-Menten plot is an important skill to have in the biomedical field. Drug development is based on a concrete understanding of how the enzymes being targeted work under normal conditions. By gathering their own data, plotting, and analyzing it themselves, the learners were able to interact with the concepts behind the Michaelis-Menten plot, and thus shape their identities and biochemists. In order to get learners interested in exploring the Michaelis-Menten enzyme Kinetics we contexted the raising questions portion of the inquiry activity as though the learners were being recruited to a new company. We gave them a letter from the Kinet-X team staff welcoming them to the company. The letter outlined their roles as biochemists and the need for proposals on what type of experiments to run given the materials available to them. Once they conducted their experiments they then had to figure out how to analyze the data in a meaningful way. While there was one way the learners had to run the experiments, the paths they took to come up with their outlines were different. The learners had the most freedom when it came to analyzing their data, and could either convert units first then graph then start to analyze their data, graph first then realize they need to convert units when they attempted to analyze data, etc.

Once the learners had converted and analyzed their graphs to reveal how well their substrate worked with the enzyme they were asked to make a poster presentation with the following prompt:

1. Sketch your Michaelis-Menten Plot from your given data

2. Please include the kinetic parameters (e.g. turnover number, concentration that gives 1/2 Vmax, Vmax)
3. Please make a claim as to which parameter (or parameters) your group has decided is the best to use when comparing the efficiency of different substrates with one enzyme. Please give a one or two explanation behind your claim.

Then each team presented their findings and discussed as a group which parameters they felt were the best to use when comparing efficiency of different substrates for one enzyme. They all came to the conclusion that one had to look at both the turnover number, and the concentration at which ½ Vmax is reached.

We then had the learners complete the following Culminating Assessment Task (CAT) prompt on their own and turn in their individual reports:

Using the enzyme kinetic plots obtained from your experiments make a claim about which substrate works best. Use evidence and reasoning to support your claim, and write up a short report to send back to Enzyme Kinet-X drug design team.
Please be sure that your report includes the following:
1. The substrate your team claims to react most efficiently with the enzyme.
2. Please list the concepts of catalytic efficiency, turnover, and enzyme affinity for your comparisons in your substrate.
a. Indicate which value, catalytic efficiency, turnover or concentration at ½ Vmax is the best choice for comparison.
3. Give a brief, 3-5 sentence, explanation of how/why the piece of evidence your team identified in 2a gives support your claim in part 1.

We assessed the content of the individual reports using our content rubric which was out of a total of 9 possible points. Each dimension of the content (as listed above) was worth 3 points. Of the 12 students, about 7 of them received full points for the individual assessments while others the rest were all within 1 or two points of the maximum score. As shown from the learners' scores on the content many of them understood the main concepts of enzyme kinetics. As for the practice rubric, we scored the students based on the three dimension above which were each worth 2 points for a total of 6 points on practice. We found that many of the students were engaging meaningfully with the practice and according to the rubric most, if not all, of the students scored 6 out of 6 on the practice rubric. The rest all scored 5 out of 6. This told us that the students were becoming proficient in the practice of making a claim, and connecting the claim to evidence through reasoning.