**Pre-Post Test: Rationale**

Time and time again, people tend to say the following about mathematics: “I solved the problem, but I have no clue why and what it means.”

A large majority of students that take calculus I (MAT22X) are one of the following majors (note: all majors that need calculus are not listed):

* Engineering
* Computer Science
* Pre-Med
* Psychology

These majors need to have a basic understanding of the concepts of mathematics so that they can apply the concepts in their area of expertise. Thus, a pre-post exam that is entirely designed off of conceptual understanding will help faculty determine how much students understand the calculus topics.

**Pre-Post Test: Design**

The exam is multiple choice. Each option in the multiple choice is created from common mistakes/misconceptions that students may have. The instructor uses the pre test to help them determine the overall class understanding of ideas. If most of the class does well on one of the questions on the pre-test, then the instructor may choose to not go as in depth with that concept.

Now suppose that most of the class doesn’t do well on the questions. For example, if most students answered #1 with letter A and this is incorrect, then the instructor will address that idea through different activities in the course. Then, suppose that post-test showed most answered #1 with B, but it is still incorrect.  This informs the instructor that the activities during the semester that covered this concept shifted student thinking in the wrong direction.  Thus, faculty may need to re-evaluate HOW they covered a concept.

**Pre-Post Test: Creating Our Own**

The pre-post test that has been used for several years now is copyrighted. Faculty cannot share the questions, email them, or publish their results. While they have been given permission to use in their class, their hands are tied with the copyright rules.

Three calculus faculty have been giving this exam in their courses for approximately 3-4 years now. Issues with this pre-post test, as felt by the EMCC faculty, are as follows:

* Two questions are not calculus based – they are pre-calculus questions
* Several of the questions are poorly worded and confuse both the faculty and students
* Several of the questions have 2 possible correct answers – one option if you answer from a “math” perspective, and the other option if you answer from a “physics” perspective

With the push for students to take the calculus/physics learning community, students are confused as to which answer to choose in the multiple choice questions.

So, in Fall 2016, the calculus faculty (including 2 adjunct faculty) met before fall classes started. The faculty decided to come up with their own pre-post test after reviewing the one that had been used. In Spring 2017, Becky Baranowski met with Brooke Jenkins (Chemistry OSO). Brooke’s Master Thesis was about the creation of pre-post tests, how to write them, what makes a good question, how to collect data so that we can show concrete data, etc. Becky also met with Dwain Desbien who has been utilizing a pre-post force concept exam (physics). Dwain also has a background in creating these type of exams, and his Ph.D is in physics education in which his goal is to get students to conceptually understand physics.

After meeting with Brooke and Dwain, Becky drafted a pre-post test with the help of Jennifer Shannon (math), Ernie Chavez (math), Dwain Desbien (physics), Angela McClure (physics), Levi Torrison (Chemistry) and Fiona Lihs (Chemistry). Questions, with multiple choice responses, were created. Levi and Fiona took the exam and provided their feedback to the questions.

On April 13th and 14th, 2017, sixteen students volunteered to take the exam, provide their rationale as to why they chose the multiple choice question they did, and were interviewed. The sixteen students were a mix of calculus I, II III and differential equations students. Students had three different instructors for calculus. Student feedback included, but not limited to, the following:

* Change wording
* Add/Change multiple choice options
* Change graphs
* Eliminate three of the questions
* Two of the questions, students felt were more of a final exam question – procedural. They stated that the questions were not conceptual.
* The exam was overall very heavy in derivatives, and most of them got one particular problem correct. So, they recommended taking this one off to cut back derivative questions.
* Re-label graphs

As of 4/19/17, two calculus faculty will give this updated pre-post test in their MAT22X course the last week of the Spring semester. While we will not have pre-test scores to see how students have grown, but this will give us a chance to see how students do on the exam. This exam will be modified throughout the next two years as the calculus faculty see common themes. Becky Baranowski is considering having this become part of her dissertation as she begins her doctoral program May 5, 2017.