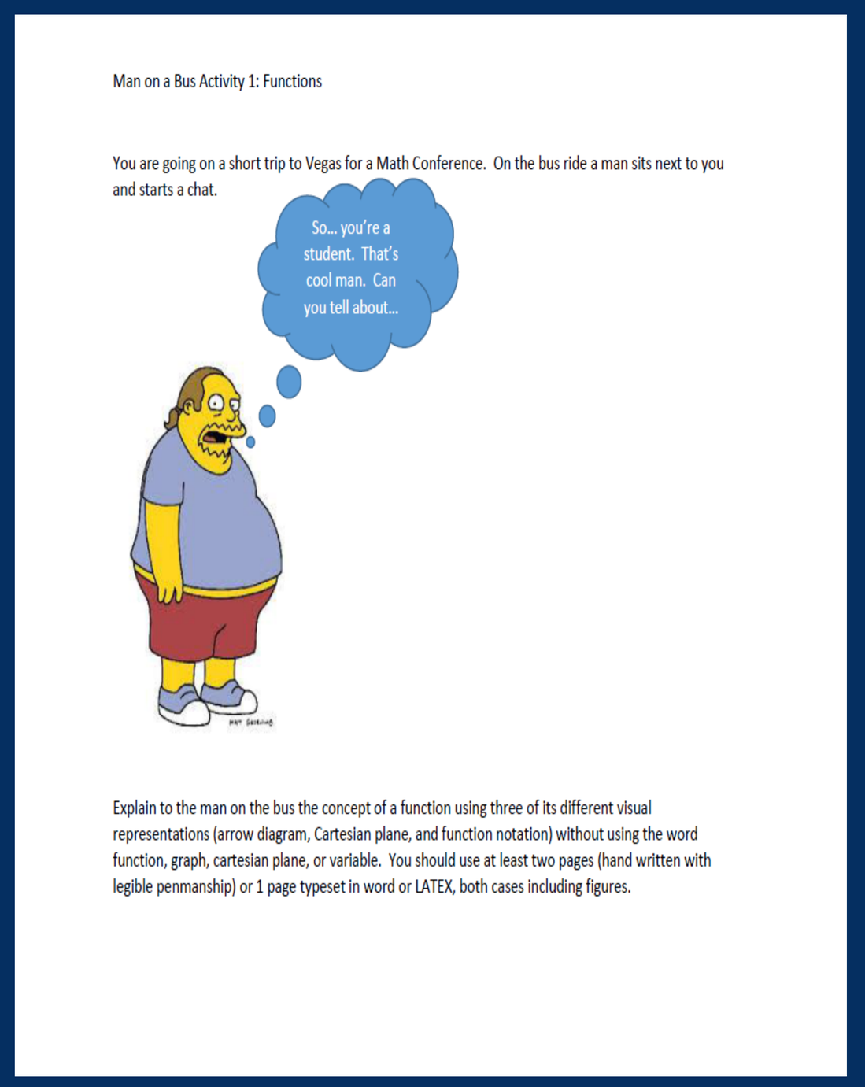
Wells and Woes of my first attempt at becoming a Master at Mastery Grading

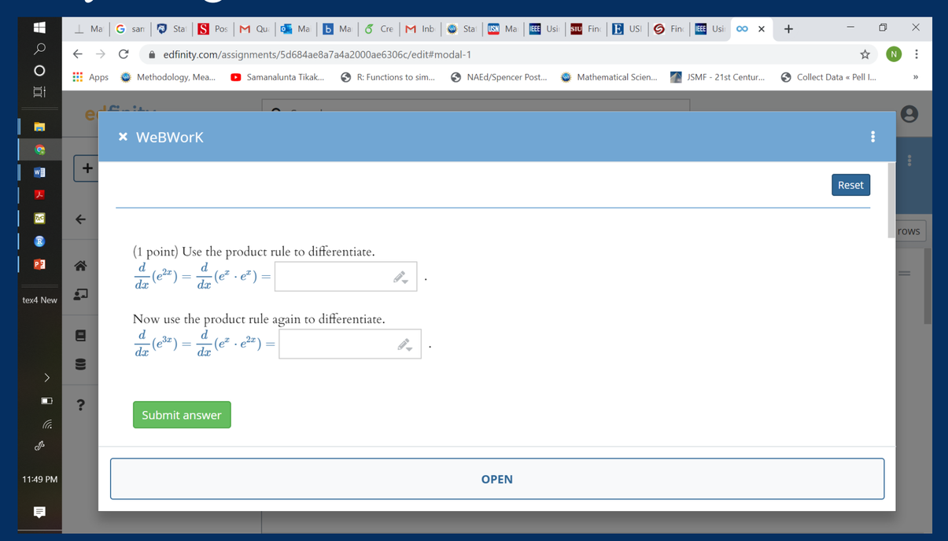
Rationale

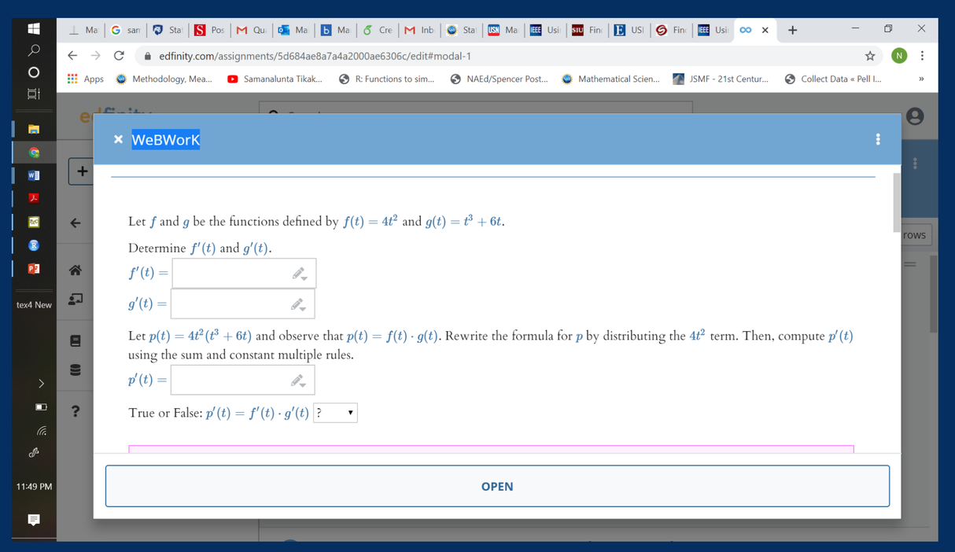
Most college level courses, in particular STEM courses, use a traditional approach to grading. Here a grade is assigned for a particular evaluation instrument (e.g., quiz, homework assignment, test, project, presentation), the material is reviewed following the grading process (in class directly or presumably by the student) and the class moves on to new materials. The student presumably learns from his or her mistakes. Despite the assumed improved knowledge, the student's grade for the assessment only represents what he or she "knew" at the time of the evaluation. Furthermore, the overall course grade is typically a composite of these separate evaluations, and therefore, probably not a measure of the level of a student's knowledge at the completion of the course. Nonetheless these final course grades are typically used as an indicator of a student's achievement in job applications and applications for graduate education, scholarships, and more. Moreover, it is not clear what the real purpose of grades is-whether they are an indicator of a student's knowledge, effort, ability, or some combination of all three.

For many students, grades are an important motivator. Various models of learning suggest that grades can be used to increase learning. Mastery grading is one approach that has become increasingly popular and as more research is done, greater evidence of the effectiveness of this approach compared to other grading approaches on learning outcomes for students is shown.

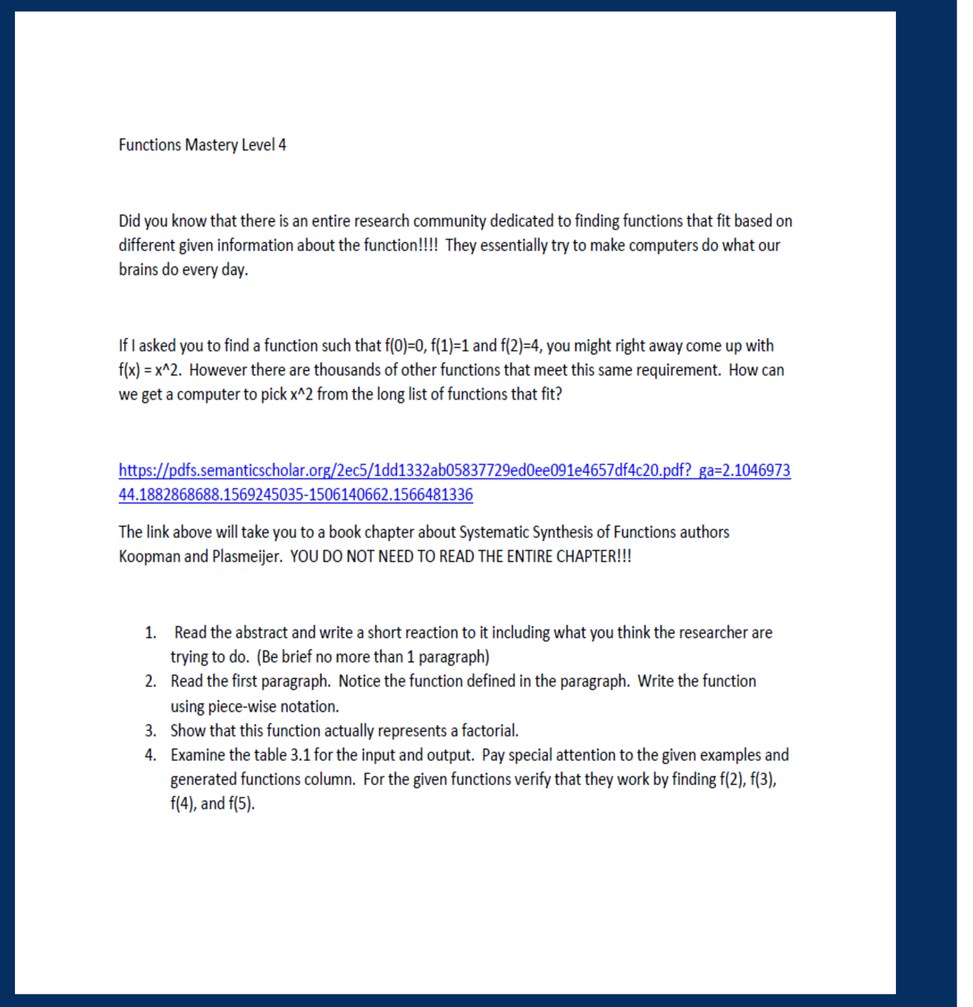
Sample Mastery Assignments Level 1







Sample Mastery Assignments Level 4



Mathematical connections between bond-stretching potential functions

Motivations

Ultimately as an professor my goal is for my students to learn the course materials and not just "pass" the class. This motivation is often not shared by the students who typically are focused on passing with a certain grade on their transcripts and may not be interested in a full understanding of the course materials. (Sad but True)

So,

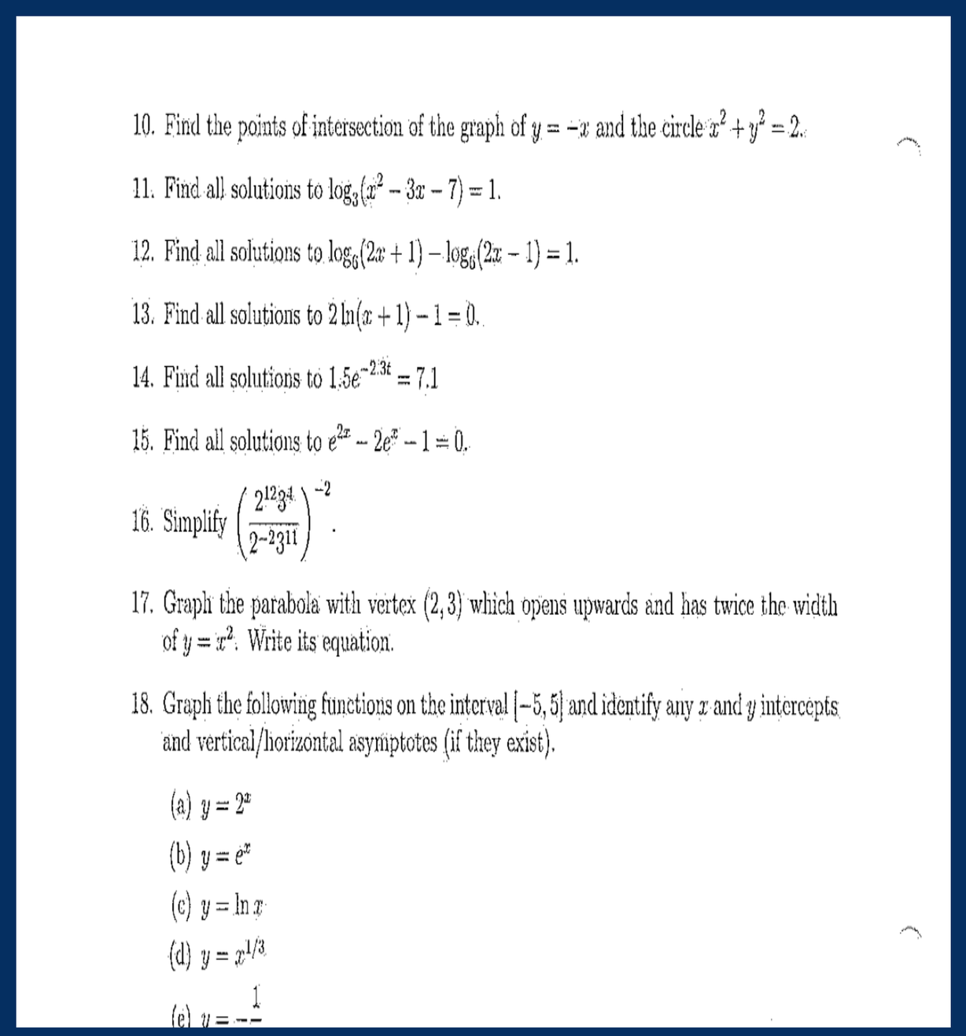
How do I motivate my students towards learning and not just passing?

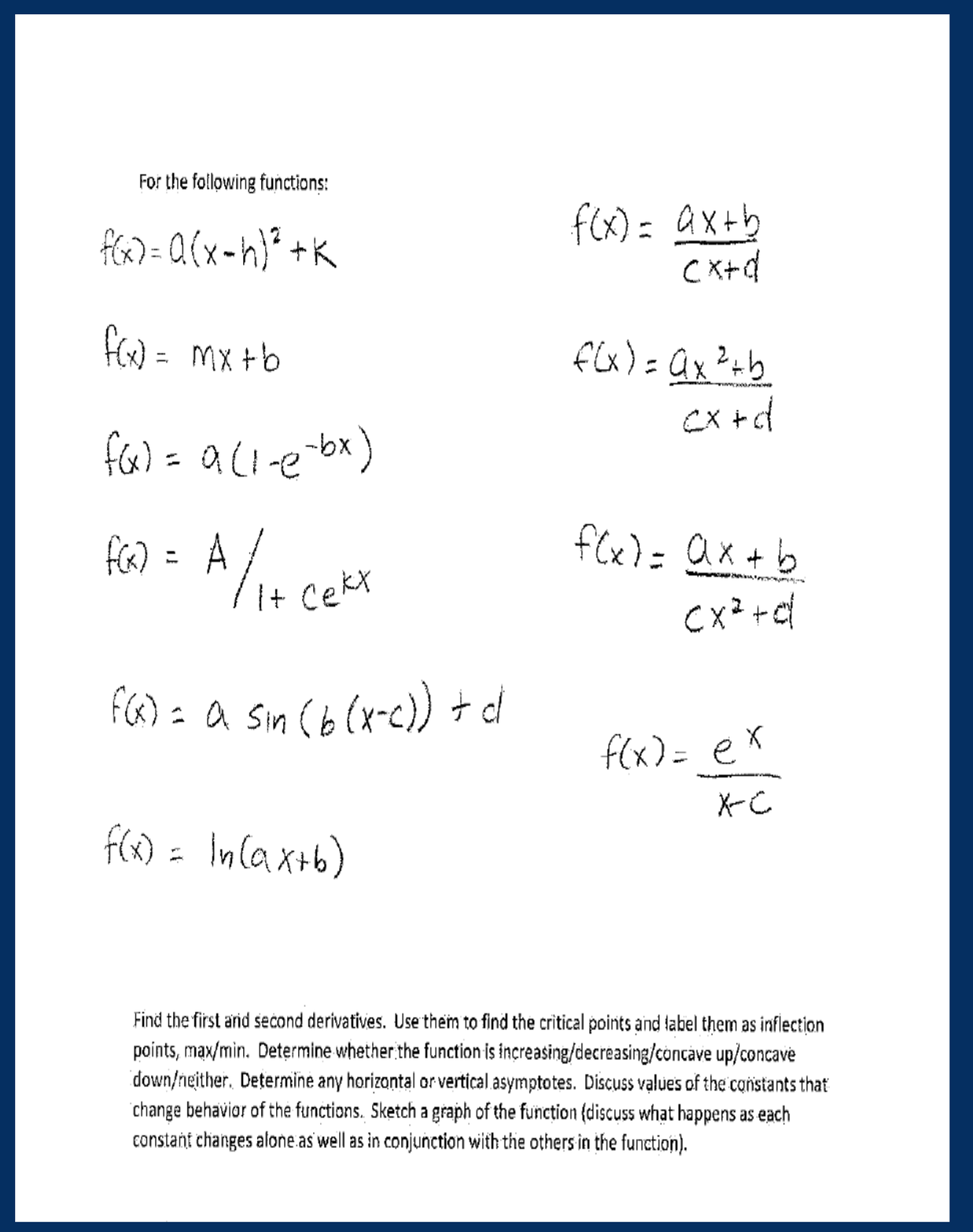
How can I set up my course so that the grade students receive does actually reflect their knowledge leaving the course?

How can I use grades as a motivator for mastery of learning?

These are questions I asked of myself and these same questions motivated me to attempt mastery based grading for my Calculus and Analytic Geometry Course Fall 2019.

Sample Mastery Assignments Level 2





For the following functions:

$f(x) = a(x-h)^2 + k$

$f(x) = mx + b$

$f(x) = a(1 - e^{-bx})$

$f(x) = A / (1 + ce^{kx})$

$f(x) = a \sin(b(x-c)) + d$

$f(x) = \ln(ax + b)$

$f(x) = \frac{ax+b}{cx+d}$

$f(x) = \frac{ax^2+b}{cx+d}$

$f(x) = \frac{ax+b}{cx^2+d}$

$f(x) = \frac{e^x}{x-c}$

Find the first and second derivatives. Use them to find the critical points and label those as inflection points, max/min. Determine whether the function is increasing/decreasing/concave up/concave down/neither. Determine any horizontal or vertical asymptotes. Discuss values of the constants that change behavior of the functions. Sketch a graph of the function (discuss what happens as each constant changes alone as well as in conjunction with the others in the function).

Wells and Woes:

Cheating: It quickly became clear that many students were cheating so that once one person mastered the assignment (typically by going to the SI instructor) a whole group of them would "magically master" the assignment with all the same mistakes.

Due Dates: Assignments were not given with due dates so students could turn in a mastery attempt at any time. Special mastery days were schedule for the class so that students could work towards Mastery. On these days students were encouraged to turn in at least two assignments for mastery check. However, most students procrastinated.

Return/Feedback: I was not able to return mastery assignments in a timely fashion so many students were waiting for feedback. I attempted to combat this by always having something for students to do in the interim, but that did not sit well psychologically for some students.

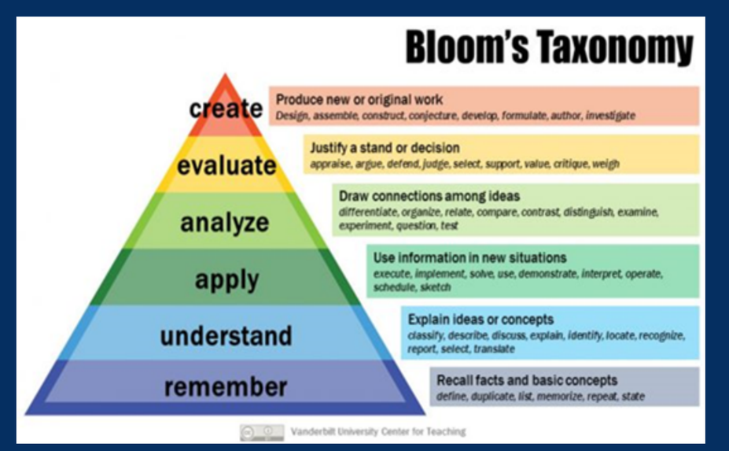
Grading Scale: The mastery grading scale was 0/1 which would indicate that you mastered a level or did not. However, this grading scheme was daunting and did not reflect the different levels of student mastery. I need to extend it to include progressive levels of mastery.

Set up

Mastery Based Grading Homework Assignments:

1. Mastery graded homework assignments

Level 1: Mainly procedural/Calculations Based assignments – Remember, Understand, Apply
Level 2: Building on Procedural, Exploring more conceptual – Analyze/Evaluate
Level 3: Building on Procedural and Analyzing abilities, more abstract conceptual –Analyze/Evaluate
Mastery: Usually 1-3 problems that involves read/exploring something new and combining past knowledge to find a solution to a new problem - Create

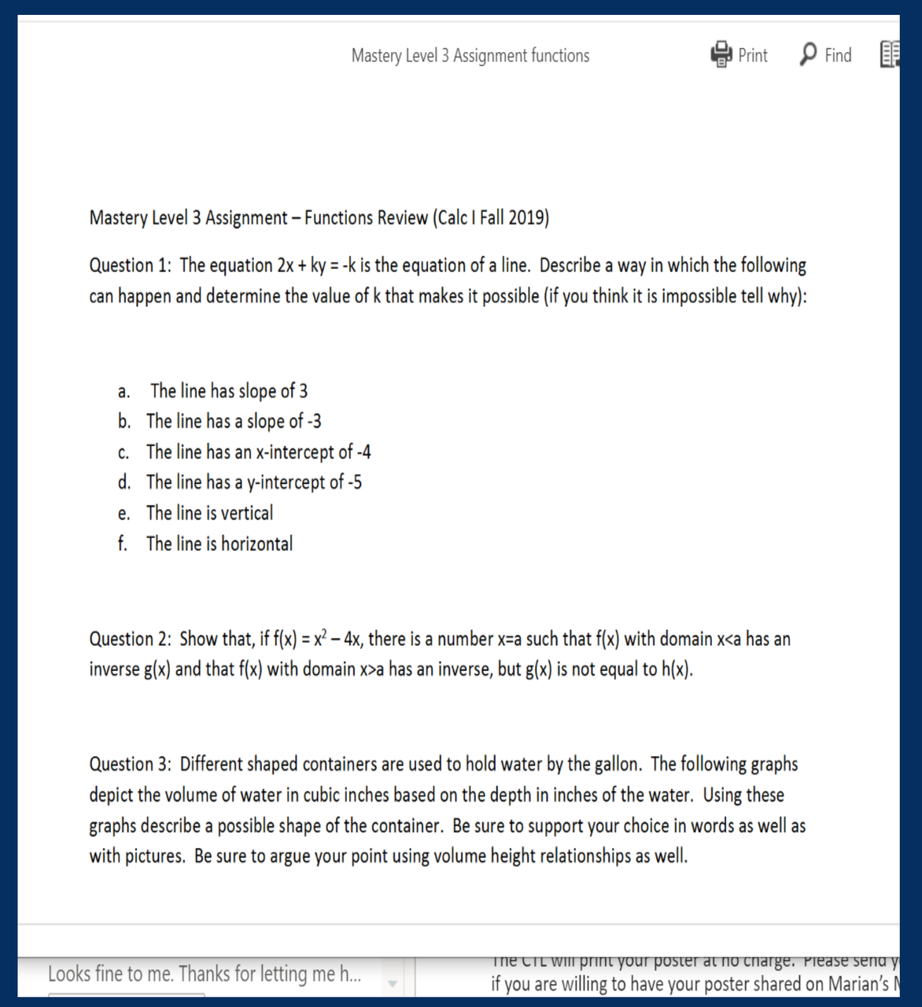


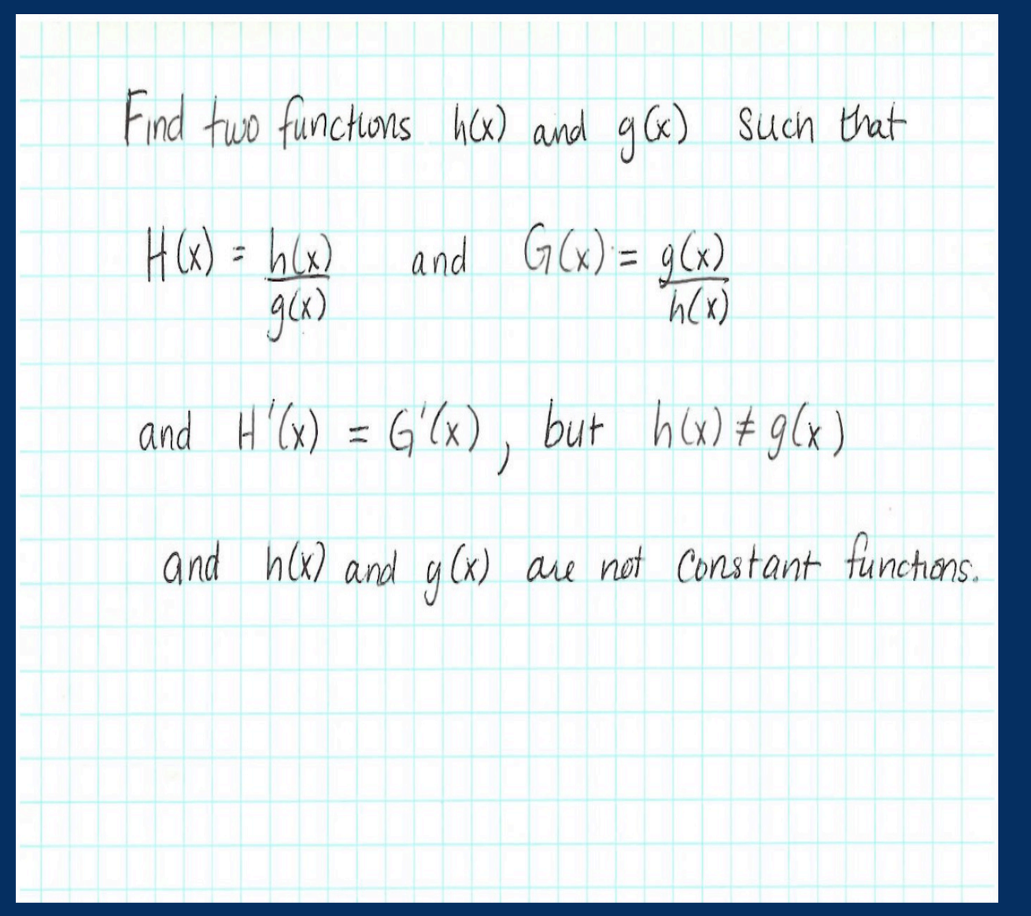
This is the text as it appeared on the course syllabus accompanied by the two graphics of Bloom's taxonomy for learning.

The course was broken up into 4 different sections: Functions, Limits, Derivatives, Basic Integration

Each section consisted of 4 levels of mastery which consistently contained the same elements:
Level 1: Writing Assignment, Problems solved on a mathematical software Edfinity
Level 2: A worksheet typically given in class
Level 3: A shorter more involved worksheet (typically 3-4 problems that extend the concepts
Level 4: The concepts in a new situation (typically an application of the calculus concepts)

Sample Mastery Assignments Level 3





Find two functions $h(x)$ and $g(x)$ such that

$H(x) = \frac{h(x)}{g(x)}$ and $G(x) = \frac{g(x)}{h(x)}$

and $H'(x) = G'(x)$, but $h(x) \neq g(x)$

and $h(x)$ and $g(x)$ are not constant functions.

For Future Iterations

Overall Mastery Grading did motivate some students to be more focused on learning. So it is a keeper.

Levels: The different levels worked well and using Bloom's Taxonomy as a guide was another bright spot. Also a keeper.

Due Dates Do over: Instead of allowing assignments to be turned in at any time. I plan to set a mastery by date for each of the sections. Additionally, I plan to keep Mastery Thursdays but put a cap on the number of assignments that can be turned in per week. So that students should submit a minimum of two and a maximum of four assignments per week.

Assignments Grading: I plan on making some assignments shorter and requiring explanations only for a subset of the problems in an assignment so that students are not overwhelmed with the volume of assignments and having to write an explanation for every problem. This will hopefully help with returning assignments sooner as well since I will not have to read all of the explanations.

Cheating: I have no solution for this at this time, but I welcome suggestions.

Student Comments:

"She gave to much homework for no deadlines. Because be realistic we are college students we are not going to do them to much ahead of time."

"Nobody knew what was due until about week 6. "

"With multiple types of homework and no deadlines, it was easy to lose track of what assignments needed to get done. In addition, her demands for complete mastery of assignments to earn any credit seemed unreasonable and her feedback was often vague. "

"While I understand and appreciate that she was trying to get us to put in effort and work through problems on our own, I feel that her expectations were too high considering this was the first calculus course many of us took"

"if this class was supposed to be set up as a mastery class, where students could redo assignments until mastered, I feel like more effort needed to go into returning these assignments quicker. Either that or assign less."

"The way the course was structured with "mastery" was a new experience for me. I have taken several calculus classes and I feel this was the most mentally stimulating class I have taken. I have never had so many real life applications given in a calc class and the way they were given with mastery made me feel like I was finally being challenged in a real college classroom"