Antiracist Pedagogy Workshop Reflection

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Track C: Anti-racist Assessment Practices
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Specifications Grading

The Basics

- Every assessment has clear, detailed **specifications** (specs) that indicate what constitutes acceptable work; this may include models
- Specs reflect the standards of **B-level work** or higher
- The purest form of specifications grading involves a **single-level rubric** (pass/fail) but if more nuance is desired, the **EMPX rubric** is a good alternative
- Assignments don't get scored, but instead feedback is given on why the assignment does not meet specs
- There are **opportunities for revision** when assignments don't meet specs; this may be governed by a **token** system, where students are allowed a certain number of revisions throughout the term
- Course grades are tied to successful completion of **bundles** of assessments—bundles corresponding with higher grades entail more work or greater challenge
- Assessments are tied explicitly to **unit-level learning outcomes** (more detailed than course-level outcomes)

The Benefits

- Students have to demonstrate proficiency with key outcomes in order to earn a passing grade—one can't pass by performing marginally on everything and mastering nothing
- Grades are tied directly to achievement of learning outcomes
- Bundle choice allows students to take more ownership of their grade and gives them flexibility
- Specs make expectations clear and reduce ambiguity in grading
- Feedback is actually consumed by students since they need to understand it in order to revise

Why is This an Anti-racist/Pro-equity Assessment Practice?

- Specs provide transparency and make expectations explicit—this reduces the effect of a student's background in their ability to perceive "unwritten rules"
- The inherent flexibility of the revision and "bundle" systems allow students to work around their varying life circumstances more easily while still being held to a high standard
- Giving credit for achieving mastery rather than averaging grades over a whole term allows students with weaker backgrounds to avoid "starting in the hole", which perpetuates inequity

Implementing Specs Grading in College Math Classes: Sources

- https://www.artofmathematics.org/blogs/cvonrenesse/specifications-grading-and-ibl: a blog post by Dr. Christina von Renesse
  - Describes her implementation of specs grading primarily in two courses: math for elementary teachers and second-semester calculus
  - Includes examples of syllabi and rubrics
  - Two unique components:
    - Homework Stories: solutions with explanations written for fellow-student audience
    - Conceptual Understanding Weighted System: a way to write exams that differentiates between facts, skills, methods, and conceptual understanding
  - Includes a lot of self-reflection as well as student feedback
- https://scholarship.claremont.edu/cgi/viewcontent.cgi?article=1049&context=codee: a journal article on how specs grading reduces anxiety for students in an ODE course
  - Includes 4-point rubric and list of outcomes for course
  - Lots of data and analysis
- https://web.sas.upenn.edu/ancoop/2018/01/01/specifications-grading/: a blog post by Dr. Andrew Cooper
  - Brief but thorough
  - Includes an interesting analysis of the issues with traditional grading
  - Includes a syllabus for a Real Analysis course

A Detailed Look: Robert Talbert (Calculus and other courses)

Sources

- https://rtalbert.org/specs-grading-iteration-winner/: a blog post about the various iterations of specs grading he has tried, with a focus here on Discrete Structures 2 (a course that would come after our MTH 231)
- https://roberttalbert.medium.com/specifications-grading-with-the-emrf-rubric-426a5b191a65: article on the EMRF rubric (now transformed into the EMPX rubric)
- https://github.com/RobertTalbert/calculus: Github repository on his most recent iteration of specs grading in a first-semester calculus course, which includes:
  - Syllabus
  - Outcomes
  - Assessments
  - Instructional PPTs
  - Note: everything in the rest of this document is copied from this Github repository, and the links have been left in
  - Note: this course is run in the “flipped” style and some assessments reflect this

An Introduction to the Rest of This Document

When reading about specifications grading, I found it challenging to picture the details of how it would apply to a math course and what kind of preparation would be involved. Seeing all of the documentation that Robert Talbert has provided for this course really helped me to wrap me head around what that implementation could really look like.

Most of this information is copied directly from material he provides to students, hence the "you should", "you'll complete", etc.

To organize this material, I started with the different kinds of assessments in the course and copied or created tables to capture the following information for each assignment type:

- What does that assignment look like?
- How is it graded? (I.e. what version of Pass/No Pass is used?)
- What does Pass mean?
- How do revisions work?

Then I moved to how students are given flexibility in the course:

- How do tokens work?
- What do students have to complete to earn a specific course grade?

In Robert's setup, the Learning Targets assignments are most explicitly connected with individual course outcomes, so I included his targets (outcomes) and their specific grading criteria.

And finally, in the interest of providing something even more concrete, I've included snapshots of representatives of two major types of assessments.

Much more information and details can be found at the GitHub link on the preceding page.

A final note: I think the complexity of this structure and the reading required of students is fine for a calculus class, but would definitely be too much for a developmental student. I have not yet found any good examples of using specs grading in a developmental math course, but will continue to look.

How Grades are Earned

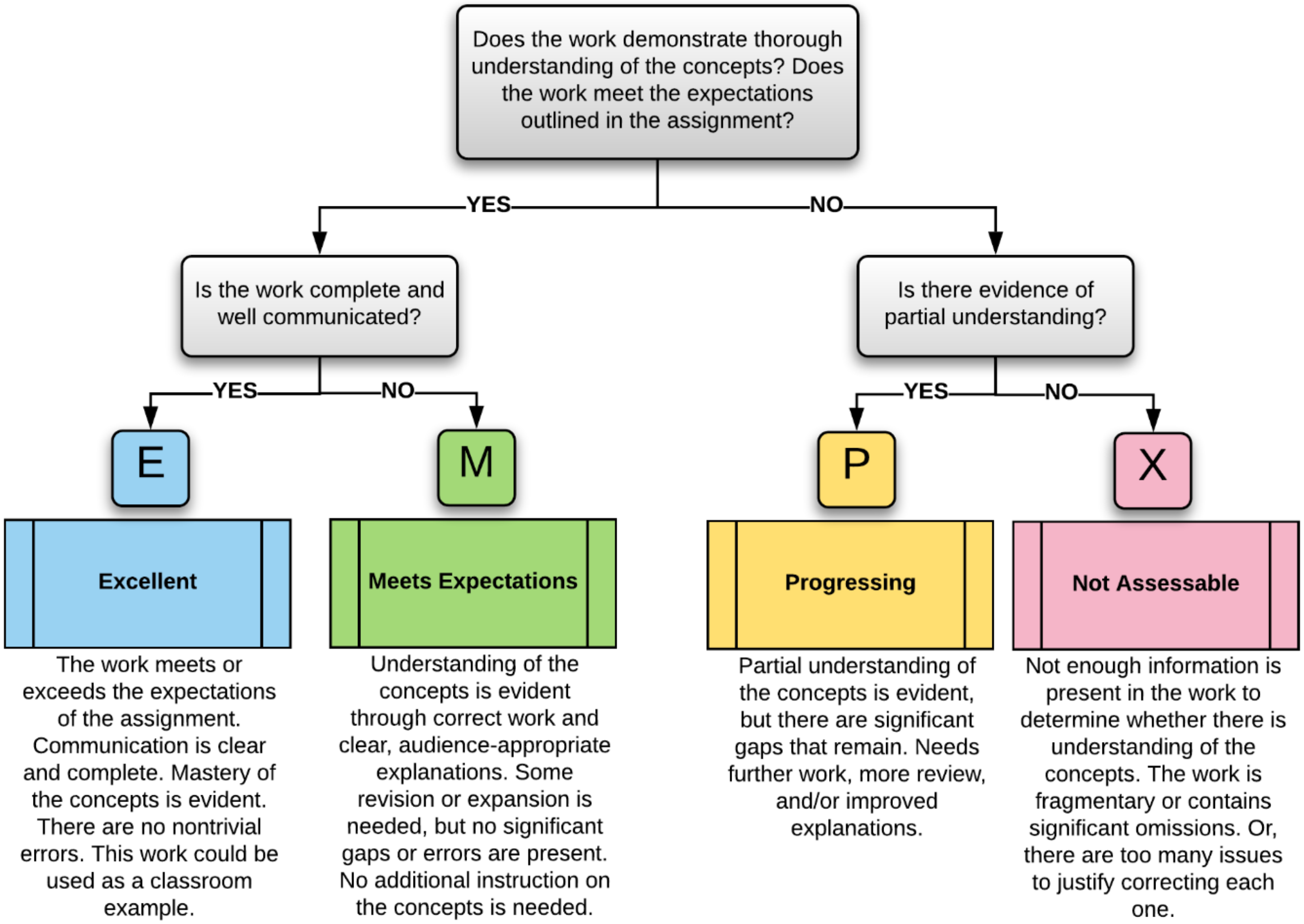
Assignments and Marks

Assignment	Description	How it's marked
Learning Targets	There are 16 *Learning Targets* in the course. These are the main tasks that you should be able to do if you are successful in MTH 201. Six of these are designated as **Core** learning targets because they are the most essential topics in the class. *Your main goal in the course is to provide evidence of skill on as many targets as possible.* You will do so through **Checkpoints** which are do-at-home exams.	Either ***Proficiency*** or ***Mastery***
Application/Extension Problems (AEPs)	AEPs are extended problem sets where you will either *apply* basic content to real-life problems or explore *extensions* of those concepts beyond what's in the textbook. There will be between 8 and 10 of these, and you'll choose several (up to 6) from among these to complete.	**EMPX Rubric**
WeBWorK	Online homework assignments to help build your computational skills. You will receive 16 problems per course module, each worth 1 point, for a total of 192 points available.	Each problem is **1 point**
Daily Prep	Daily reading and videos, with exercises and questions to be submitted prior to class. These will help you learn the basics of new material and prepare you for more application-focused work in class. There will be two Daily Preps per module, for a total of 24.	**Pass** or **No Pass**
Startup assignments	During the first few weeks of class, you'll complete three assignments designed to get you set up in the course and do some review of precalculus math.	**Pass** or **No Pass**
Final Exam	Focuses on big-picture questions and reflections on your experiences in the course	**Pass** or **No Pass**

How Marks are Earned

Assignment	How Marks are Earned
Learning Targets	The two ratings of *Proficiency* and *Mastery* are assessed on **Checkpoints**, which are do-at-home exams offered roughly every 10-14 days (a schedule is in the Appendix of this syllabus). Checkpoints contain one problem (often with multiple parts) per Learning Target. Each problem is graded separately and has its own criteria for what is "acceptable" work. **A Proficiency rating is given if you complete *one* Checkpoint problem that meets the criteria; a Mastery rating is given if you complete a *second* Checkpoint problem that meets the criteria.**
Application/Extension Problems (AEPs)	See the EMPX rubric
WeBWorK	Most problems on WeBWorK sets are worth 1 point each; some offer partial credit. The point is awarded if the answer is correct.
Daily Prep	A *Pass* mark is given if the Daily Prep is turned in before its deadline and if *each item* on the Daily Prep has a response that represents a *good faith effort to be right*. **Mistakes are not penalized**. In fact one purpose of Daily Preps is to provide me with information about issues that the class is having, prior to class meetings. A *No Pass* is given if an item is left blank (even accidentally), has an answer but it shows insufficient effort (including responses like "I don't know"), or if the Daily Prep is late.
Startup assignments	The Pass/No Pass criteria for these are specified on the individual assignments.
Final Exam	Not discussed in the Github Repository, but see this link for his Fall 2020 Final Exam: https://docs.google.com/document/d/1KmIzYaEGTf3ybHo_P51tm-x2sWWmedygdldt14q317Q/edit

EMPX Rubric



EMPX rubric based on the EMRF rubric, due to Rodney Stutzman and Kimberly Race: http://eric.ed.gov/?id=EJ717675

How Revisions Work

Assignment	How Revisions Work
Learning Targets	**Learning Targets** are assessed by Checkpoints as described above. **Each Checkpoint is cumulative**, so for example Checkpoint 2 will cover some new material plus material from Checkpoint 1, and so on. **Each Learning Target will appear on four (4) consecutive checkpoints**; for example, a problem for Learning Target 3 first appears on Checkpoint 2 and new versions of that problem will appear on Checkpoints 3, 4 and 5. In this way, if you work a problem on a Checkpoint that doesn't meet the standard, you can just try it again at a later Checkpoint. However: **After four Checkpoints, the Learning Target is "retired"** and will only appear on the final two Checkpoints (or by request if you spend a token, explained later), so you do need to tackle Learning Targets early and fix any misconceptions you have on them reasonably quickly in order to earn a Mastery rating (which is earned by completing two Checkpoint problems successfully).
Application/Extension Problems (AEPs)	**AEPs** earning M, P, or X can be revised and resubmitted at any time by reflecting on the feedback you receive, making corrections and rewrites, and then re-uploading the new draft to Blackboard. You may only submit **two AEP items per week** --- either initial drafts of two different AEPs, two revisions, or one of each. A third submission in a week can be purchased with a token (see below), but four or more submissions in a week are not allowed under any circumstance. Also, **you must spend a token to revise an AEP that earned a grade of "X"**; this is in place to make sure your AEP drafts represent a complete and good-faith effort.
WeBWorK	**WeBWorK** problems can be redone and resubmitted as many times as you need until the deadline. However they cannot be redone once the deadline has passed.
Daily Prep	**Daily Prep** assignments *may not* be revised or resubmitted. They are graded on completeness and effort only, and therefore can only be done once. However, you can spend a token to convert a "No Pass" mark to a "Pass" if needed.
Startup assignments	Revision options for the startup assignments are specified in those assignments.

Tokens

Each student starts the semester with 5 **tokens**, which can be used to purchase exceptions to the course rules. The token "menu" is below. To spend a token, go to the *Token Spending* form (found in the in the *Submit a Form* area on Blackboard), fill it out, and submit it. Once the form is submitted, the item you purchased is yours; you do not need permission or confirmation. Everything listed here costs 1 token:

- Submit a third AEP in a given week.
- Submit a revision of an AEP marked "X".
- Extend the deadline on a Checkpoint by 12 hours.
- Extend the deadline on a WeBWorK set by 12 hours.
- Convert a "No Pass" on a Daily Prep to a "Pass".

Requirements for Course Grades

Grade	Learning Targets with Mastery (out of 16)	AEP's with M or E (out of 8-10)	WeBWorK points (out of 192)	Daily Prep Passed (out of 24)	Startup Assignments Passed (out of 3)
A	15 *including all 6 Core*	6 *including at least 3 E's*	170	22	3
B	13	5	150	20	3
C	11	4	130	18	3
D	5	2	100	12	n/a

Additional notes:

- The grade is the *highest* row for which *all* requirements have been completed
- Plus/minus grades:
  - At instructor discretion based on how close student is no next-highest or lowest level
  - Must earn “pass” on final exam to be eligible for plus
  - “No pass” on final exam means automatic minus

Learning Targets (Unit-level objectives) for Calculus 1 with Target-Specific Grading Criteria

Note: I've only included the first 12 out of his 16, which correspond best to the material in our MTH 251

Learning Target	Tasks	Acceptable work means...
1	Given a function and an interval, compute the average rate of change of the function on that interval. Or, given the position function for a moving object and a time interval, compute the average velocity of the object on that interval.	All answers must be correct unless a mistake is the result of a simple error; the setup for each calculation must be shown and correct.
2 CORE	Given a function, find the limit of the function as the input approaches a point (possibly from just one side) or at infinity using algebra, table estimation, or a graph.	All answers must be correct unless a mistake is the result of a simple error; the setup for each calculation must be shown and correct. Algebraic approaches must use correct algebra.
3	Given a formula for a function (usually a second-degree polynomial), write out the correct limit expression that would compute the derivative of that function at a point or in general; then work through the limit to find the derivative. ("Derivative" might be phrased as "instantaneous velocity".)	**All limit setups must be 100% notationally correct**, including: the limit must be present and on the correct side of the equals sign; the limit must have the correct notation underneath it; and the difference quotient must be correctly stated. *Any* omissions or errors on this element will result in unacceptable work. The computation of the limit must use correct algebra throughout and result in a correct answer.
4 CORE	Given a real-world context, give a notational expression for the rate of change; state the units of the derivative correctly; give a correct and simple interpretation of the meaning of the rate of change; and estimate the rate of change using forward, backward, and central difference approximations.	Every instance of this Learning Target will present you with a derivative and ask for its units; you **must** give correct units here. Giving them incorrectly here and then correcting yourself later on is considered unacceptable work. The explanation of the derivative must use simple language and no technical jargon; and it must explain the derivative in terms of rates of change. The answers on approximation questions must be correct and the setup must also be correct.
5	Given graphical or numerical information about a function or one (or both) of its first two derivatives, draw correct conclusions about the missing information. (For example, given a graph of f, state where f' is positive and negative and where f'' is positive and negative. Several variations on this idea are possible.)	The conclusions drawn from the given information must be correct *and* backed up by a *clearly expressed* explanation that is *also* correct. That is, correct answers with no explanation, incorrect explanations, or unclear or incoherent explanations will not be considered acceptable.

6 CORE	Given 4-5 simple functions (constant, power, polynomial, exponential, and sine/cosine functions), use basic rules to compute their derivatives and answer simple application problems (slope of a tangent line, rate of change, second derivative).	All answers must be correct; if the work requires more than one step, each step must be shown
7 CORE	Given products, quotients, and composite functions, use the Product, Quotient, and Chain Rules to compute their derivatives and answer simple applications problems (see above).	All answers must be correct and accompanied by complete, correct solutions. You must also state which rule you are using and in the case of the Chain Rule, correctly state the inside and outside functions involved in the composition.
8	Given "advanced" functions (meaning logarithmic, trigonometric, and inverse trigonometric functions along with simpler functions that are combined with these), find their derivatives and answer simple application questions.	All answers must be correct and accompanied by complete, correct solutions. You must also state which rule you are using *in the correct order in which they are used* and in the case of the Chain Rule, correctly state the inside and outside functions involved in the composition.
9	Given a function (generally as a formula), use Calculus and a correctly-formatted sign chart (see below) to find its critical points and its intervals of increase and decrease.	First, your first derivative computation and determination of the critical points must be correct except for one simple error allowed. Second, there must be a correctly setup and labelled first derivative sign chart used that includes: a clear list of all the test points used and their results for the sign of the derivative; a number line with the critical points clearly labelled; a clear indication of the sign of the first derivative on each interval created; and a clear and correct indication of the behavior of the original function on each interval. Finally, there must be a clear statement of the intervals on which the function is increasing and decreasing.

10	Given a function (generally as a formula), use Calculus and a correctly-formatted sign chart (see below) to find its inflection points and its intervals of concavity.	First, your first and second derivative computations must be correct except for one simple error allowed. Second, there must be a correctly setup and labelled second derivative sign chart used that includes: a clear list of all the test points used and their results for the sign of the derivative; a number line with the critical points of f' clearly labelled; a clear indication of the sign of the second derivative on each interval created; and a clear and correct indication of the concavity of the original function on each interval. Finally, there must be a clear statement of the intervals on which the function is concave up and concave down and a clear statement of the inflection points.
11	Given a function (generally as a formula) that is continuous on a given closed interval, use the Extreme Value Theorem method to find its absolute minimum and maximum values.	The first derivative computation and determination of the critical points must be correct except for one simple error allowed. No extraneous points (for example critical numbers outside the interval, or numbers that are neither critical numbers nor interval endpoints) should be tested. A clear indication of the points being tested and the results of the test must be given, and a clear statement of the absolute minimum and maximum must be made.
12 CORE	Given a simple (WeBWorK-level) applied optimization problem, set it up, find the point where the target quantity is optimized, and give a mathematical explanation for why the quantity is optimized there.	If the problem involves a diagram, it must be clearly drawn and correctly labelled with the variables being used. It must be clear from either the diagram or a separate declaration what each variable stands for in the problem. You must clearly state what quantity is being optimized, then give a clear statement of a formula for that quantity that includes intermediate steps if needed. If you use a constraint in the problem to arrive at the target formula, it must be clearly stated and correctly derived. You must use correct calculus to find the critical value(s) of the target formula. Then **you must give a correct and clear mathematical argument for why your answer actually optimizes the target quantity.** This can be done using the First Derivative Test, Second Derivative Test, or (in some cases) the Extreme Value Theorem.

Overall grading criteria for Checkpoints

***Each* Checkpoint problem requires at least the following from a solution in order for that solution to be considered "acceptable"**:

- **There can be no instances of significant errors.** A "significant" error is one that is *directly related to the Learning Target itself* and *causes the solution to fail to provide conclusive evidence of mastery*. Examples include (but are not limited to) the following:
  - A *significant computational error* that shows more work needs to be done on mastering the computation (for example: getting the subtraction reversed in the Quotient Rule; or computing the derivative of $cos(x)$ as $sin(x)$ instead of -$sin(x)$)
  - A *significant conceptual error* that demonstrates the need to understand the concept further (for example: Getting the units wrong on a derivative; interpreting a positive first derivative as concave up; etc.)
  - An *unclear explanation* that demonstrates the need to understand the concept further
  - *Significant omissions* including not doing a part of a multi-part problem (even if by accident); or leaving out an essential part of a solution, for example the argument at the end of an optimization problem that the critical point optimizes the quantity
  - A *highly disorganized presentation of a solution* --- That is, the solution is so messy and incoherent that it is not easy for the reader to determine if the student has mastered the concept
  - A *copy error that oversimplifies the problem* -- For example, copying down $f(x) = e^{x^2}$ on a derivative question as $f(x) = x^2$ or $f(x) = e^x$.
- **There can be no more than a single instance of a "simple" error.** A "simple" error is an error that is *not directly related to the Learning Target itself* and *doesn't get in the way of seeing that the student has mastered the concept.* Examples of simple errors include:
  - *Errors in arithmetic or algebra that are not central to the Learning Target and do not oversimplify the problem*. For example, working through a derivative and everything is correct except a minus sign was dropped in the final answer.
  - *Copy errors that do not oversimplify the problem.* For example, copying down $f(x) = e^{x^2}$on a derivative question as $f(x) = e^{2x}$ is a mistake, but the derivative that results is roughly the same level of difficulty as the correct function, so I will read with your solution to make sure the answer and process are correct.

Additional Notes:

1. *Two simple errors in the same problem, no matter what the type, results in unacceptable work.* It is acceptable to make a simple error once, but not twice.
2. *Errors that are "simple" in one context may be significant in another.* For example, dropping a minus sign might be a simple error on Learning Target 6 but considered significant for Learning Target 13 where the minus sign is an important part of the concept.
3. *To avoid all forms of error, use the approved tools listed below to double-check all your work before submitting it*. For example, you can use Wolfram|Alpha to double check the answers for derivative calculations; you just need to supply a complete and clear solution. In this way, your work should never really contain errors unless they are significant conceptual misunderstandings.

Examples of Assessments and Instructions

An Application/Extension Problem (AEP)

AEP 5: Exploring logistic functions
[Note: The assignment begins with a section of background and context—see https://github.com/RobertTalbert/calculus/blob/master/assessments/aep/aep5.md for the full assignment]

Setup
You're going to build your own random logistic function to work with on this AEP, so that we're not all using the same one. Go to Wolfram|Alpha and generate the following:

- A random number between 5 and 50, and let this be L.
- A random number between 0.05 and 0.35, and let this be k.
- A random number between -5 and 5, and let this be a.

To generate a random number between two bounds a and b, just enter "random number between a and b" and hit enter. For example, here's how to generate a random number between 10 and 10000.

AEP Tasks

1. List the values of L, k, and a that you generated (and state which is which). Then go to Desmos.com, enter your logistic function with those parameter values, and adjust the viewing window so that the "S" shape is clearly visible. (Here's an example of a logistic function with a bad viewing window; here's the same function in a much better window.) In the writeup, share a link to your Desmos graph.
2. Using the derivative rules of Chapter 2, **find the first derivative of your logistic function**. You'll need to show all the steps on this and simplify completely. To make this neat and professional: First do all the calculus separately and make sure your answer is correct; then type up your work *using correct notation*. For this AEP, "correct notation" means in particular to use actual fractions and exponents, and don't type up the work using basic text input from the keyboard. For example, *20/(1+e^(-0.2(x-2)))* all in one line is not correctly formatted; writing it as $\frac{20}{1+e^{0.2(x-2)}}$ is correct. If you need help, please ask on Campuswire.
3. Does your logistic function have any critical values? If so, find them. If not, explain why not.
4. Now **find the second derivative of your logistic function**. For this, you can use Wolfram|Alpha to find the second derivative, but you need to state in your writeup the second derivative fully simplified and formatted as described earlier. Also, give the link to the Wolfram|Alpha calculation Then **make a second derivative sign chart** for your function and **find the interval on which it's concave up and the interval where it's concave down**, and **find the exact x- and y-coordinate of the inflection point**. All algebra steps can be done using Wolfram|Alpha, but please give links to any calculation you perform using that tool.
5. Look at the y-coordinate of the inflection point and compare it to the value of L, the upper limit that the function approaches. You should notice a relationship between the two. What do you notice?
6. Write a 1-2 paragraph summary of your work on this AEP, addressing the following:
   - What concepts from the course were used in your work
   - How the work you did here could be useful in a different application setting
   - Three things you learned in the process of completing this assignment
   - At least one substantive question that you still have

Grading criteria and submission instructions

Please refer to the overall quality standards for AEPs at the link (and posted to the *AEPs* area on Blackboard) first, and make sure your work meets all these criteria. In addition to the overall standards, this AEP has the following specific standards:

Mark:	**Criteria:**
E (Excellent)	All the criteria for an M are satisfied, and additionally there are no mathematical mistakes; all verbal explanations are clear, easy to understand, and mistake-free; and the presentation of the writeup is neat and professional.
M (Meets Expectations)	All the links to Desmos and Wolfram Alpha must work and show the correct computations. Both the first and second derivatives must be correct, fully simplified, and formatted as described above. (Putting your function as a single line of text, like *20/(1+e^(-0.2(x-2)))*, will result in an "P" grade and you'll need to resubmit with the right formatting. All the information needed for an "outsider" to understand your work needs to be self-contained within the work. **The reader should not have to do any work to fill in gaps.**

Please see the syllabus for how grades of **P** (Progressing) and **X** (Not Assessable) are assigned.

A Checkpoint

Snip from Directions

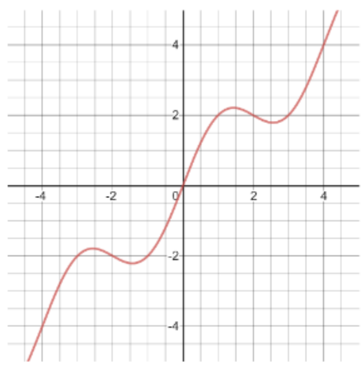
Directions:

- Do only the problems that you need to take and feel ready to take. If you have already earned Mastery on a Learning Target, do not attempt a problem for that Target! You can skip a Target if you need more time to practice with it, and take it on the next round.
- Each Learning Target problem is to be written up on a separate sheet, scanned to separate PDF files, and submitted to the appropriate Learning Target "assignment" on Blackboard. **Please do not submit more than one Learning Target in the same PDF, and make sure you are submitting it to the right Blackboard area.**

Example Learning Target Problems

Learning Target 1: *I can find the average rate of change of a function and the average velocity of an object on an interval.*

1. Let $f(x) = 3x^2 - \frac{1}{x}$. Find the average rate of change in f on the intervals $[1, 5]$ and $[2, 2.01]$. If you round, round your decimals to four places.
2. Let $g(x)$ be the graph shown below. Find the average rate of change in g on the intervals $[-2, 0]$ and $[1, 4]$.



3. A student is walking in a hallway, and their distance s (in feet) from the Math Department office at time t seconds is given by the following table:

Time	0	5	10	15	20
Distance	4	20	19	22	5

Find the student's average velocity from $t = 0$ to $t = 5$ and from $t = 5$ to $t = 20$.