Blending Team-Based learning with Standards-Based Grading in a Calculus Classroom

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Abstract: *We present here a Teaching Practice paper explaining how to prepare a course structure that implements both Team-Based Learning and Standards-Based Grading. The main goals of this course design were to increase student engagement, decrease mathematical anxiety, and more adequately prepare students for future courses. Team-based Learning allowed us to remove the majority of lecture from the classroom, leaving time for exploratory activities. Standards-Based Grading allowed for reduced subjectivity in grading, while ensuring students were accountable for their own success and more well-prepared for future courses. These teaching methods were combined in a first-semester calculus course, for two sections of 30 students, at a small mid-western liberal arts college. The method is covered in detail, including samples of how the student's readiness and mastery were assessed. Students reported feeling more engaged in the classroom, more accountable for their own success, and more likely to prefer future courses where this method would be employed. Reports from faculty teaching courses in subsequent semesters indicated students who had been involved in these courses were better prepared than their counterparts.*

INTRODUCTION

As instructors, we constantly seek ways to improve our teaching. To that end, we present a blending of techniques that overcome a variety of issues faced by students. The problems with student engagement, and the need for students to take a pro-active role in the classroom have been explored in detail, for example Halmos, Moise, and Piranian (1975). We incorporate Team-Based Learning (TBL) and Standards-Based Grading (SBG) and our techniques to try and address some of these issues. The goals of this method are four-fold. The first is Readiness. We seek to ensure that students take responsibility for preparing to learn the material, and to familiarize themselves with the importance of reading in their discipline. The second is Inquiry and Struggle. Students need to be given a framework in which they can work on guided exercises, with the emphasis being on critical thinking and the application of effort, rather than specific algorithms. The third is Productive Failure. The readiness and inquiry must lead to a situation in which students can safely fail, and where learning from that failure is built into the course. The fourth and final stage is Mastery, when a student is able to demonstrate full command of the course materials.

With any course redesign, we must start with the issues we need to correct. These are covered in the first section we discuss the literature relevant to our two methods, and the evidence of their efficacy. In our second section, we discuss in detail the implementation of the method, and provide examples of the materials. In the third section, we present the results of this implementation, and include student feedback on the method.

LITERATURE REVIEW

Team-Based Learning

The first issue we seek to address is student engagement. How can we ensure that students feel that their time in class is valuable? We seek to improve this with active-learning strategies that keep students engaged in the classroom. In practice, this means minimizing lectures, and asking students to work in team to solve complicated problems. The majority of our method here comes from the framework in Michaelsen, Bauman-Knight, and Fink (2004). Evidence suggests that traditional, teacher-focused methods, do not enable all students to engage with the material Hake (1998). We use TBL to make the change to a more student-focused method. The literature indicates that TBL can improve test scores, course grades, and student satisfaction Sisk (2011). We also know that TBL students tend to be more prepared for class Allen, Copeland, and Franks A.S (2013) and that students report learning more content Altintas, Altintas, and Caglar (2014).

We also seek to address student accountability. Students need to learn how to learn. They need to be prepared when they arrive in the classroom, and a mechanic needs to be in place to ensure that readiness is the student's responsibility. This contrasts with traditional lectures, where the students often feel it is the instructor's job to get them ready to learn. The TBL methods in Miahaelsen and Sweet (2008), Miahaelsen and Sweet (2011) ensure the students are accountable for their preparation.

Standards-Based Grading

Further accountability is passed to the students in how their grades are assigned. Students tend to see their grade as starting at an "A", and being lowered each time they make an error. By changing this so that the student sees grades as something they earn, rather than something the instructor disseminates, accountability increases.

Standards-Based Grading allows student to be graded based on demonstrated proficiency in meeting a clearly articulated set of learning objectives Reeves (2011). It is a formative assessment, where the final product of a student's participation is prioritized, rather than a summation of grades awarded at various stages in the course. This allows for students to fail in a way that is safe and productive. The idea of productive failure Kapur, Dickson, and Yhing (2010) has been shows to improve student's ability to solve mathematical problems. In both well-posed and poorly-posed problems, students who have had experience with productive failure outperformed students in more traditional lecture courses.

Productive failure is also key in increasing accountability. It is the student's decision to make a failure productive. Structuring the course so that students can use an error as a learning opportunity, rather than something that merits punishment, can be encouraging for students. Is requires accountability, as making the effort to learn from a failure can only be done by the student.

Finally, we seek to remedy issues with student's preparedness for subsequent courses. Through experience, we have learned that there is a great difference between a student who has earned 70% of the points available in a course, and a student who has mastered 70% of the content in a course. The issue is that both of those students would receive a "C" grade, and would be able to register for the subsequent course. Our argument is that only the second student is truly prepared for the next course in the sequence. It is our intention to design a multi-semester study, where students from SBG and traditional courses are followed through subsequent semesters and their retention is tested.

With these goals in mind, we redesigned a Calculus I classroom, using Team-Based Learning to make the course as active as possible, and Standards-Based Grading, to ensure accurate measurement of student mastery. As the goals of the course redesign were multi-faceted, we determined that a single approach would not achieve all of the desired results. For this reason, we blended the two approaches. The pedagogy is described in the next section.

METHODS

Team-Based Learning

Our implementation of Team-Based Learning (TBL) involves four major components, similar to Michaelsen et al. (2004). The main difference is that we do not use simultaneous reporting on our classroom, preferring to let teams work at their own pace. This is also a factor of having the students for only 50 minutes per class period, where regular breaks for simultaneous reporting were not feasible with the time constraint. The four components we take from Michaelsen et al. (2004) are:

1. Setting the Stage and Assigning Teams

2. Individual and Team Readiness Assessments

3. Challenging Daily Team Activities

4. Peer Evaluations

Setting the stage on the first day is crucial to success. Students are generally unfamiliar with TBL, and will complain when they realize lectures are not generally part of the course. It seems counter-intuitive that these complaints would exist, since students generally also complain about lectures. Explaining the course structure in detail, as well as the instructor's motivation for the alternative method, can be helpful in getting students invested in the method earlier.

The first component of a TBL classroom is the formation of teams. These should be groups of students that are assigned by the instructor, and which will last for the entire term. It is helpful at the beginning of the term to use the work "team" rather than "group". Students tend to have preconceived notions about what happens when groups are used in the classroom, and most of those notions are negative. It is common to find high-achieving students who are concerned that other team members will earn credit for work they did not complete. This method actively prevents that, so you can assure the students that this is not true.

The second component of the TBL classroom is student's responsibility for readiness. This is achieved through Readiness Assessments. Students are assigned preparation work to be completed before the class meets. This might include readings, videos, or inquiry-based questions.

Assessments are done twice. For the first attempt, the students are to complete the assessments on their own, hence the term Individual Readiness Assessment (iRAT). We have had success using a product called ZipGrade to score these assessments quickly. A sample is provided in the appendix. Once all students have completed the iRAT, the same assessment is taken in teams. This is the Team Readiness Assessment (tRAT). We have had success using the IF-AT scratch-off response cards for this, and an example is provided in the appendix.

The use of this method has been in a course with 4 50-minute periods per week. As such, an entire day is devoted to Readiness Assessments. The RATs are generally completed within 50 minutes. The instructor can spend the rest of the time delivering a short lecture on the components of the RAT where students had difficulty. This is where the use of an electronic grading system is helpful. By getting immediate feedback on the problems where some or most of the class made an error, the instructor can tailor the mini-lecture to the problem areas. Items where most or all of the students answered correctly were learned via the readings, and do not need to be addressed in the lecture.

Beginning on the day following the RATs, the student start working on Team Activities. These should be challenging questions, above and beyond the typical rote practice in a Calculus textbook. Sample daily activities are in the appendix.

There are two components to encourage student accountability in the classroom. The first is that the teams are responsible for assigning themselves credit for participation each day. Each team is given a sign in sheet, and the authority to sign in an absent teammate.

If a student needs to miss class, they inform their teammates, and if the teammates feel the absence is warranted, they can sign their absent teammate in. The instructor only assigns points based on the self-reported participation.

The second component is a peer evaluation. This starts on the first day of class, when the teams are assigned. Each team is asked to create a team contract, where effective team member behaviors are laid out. These contracts are the basis for two peer evaluations done during the semester. The first is done at midterms. Each student is given an electronic survey, where they are allowed to assign 100 points per member of their team (less themselves) to show how much their feel each other member is contributing. For example, if the team has 5 members, each student is given 400 points. They could assign the values as 100, 100, 100, 100 or as 110, 90, 60, 140, or anywhere in between. Each score must be accompanied by a comment on how a team member makes a positive contribution, and a comment on how a team member could improve their contribution. These are anonymized and distributed to the students. All critical feedback must specifically address a team behavior that was agreed upon when the team contract was written.

The purpose of the mid-term evaluations is to give students a sense of how their contribution to the team is perceived. An evaluation is also required on the final day of the course. This does not include any comments, just a raw score. A student's raw score is multiplied, as a percent, by the total team points they have earned. For example, if the team had earned 100 points, but a student's average peer evaluation was only 70, that student would only earn 70 points in their final grade calculation. It is the intention that a poor mid-term evaluation will motivate those students to correct the offending behavior, and that their final evaluation score will improve. This has almost universally been the case in the courses we have taught.

Standards-Based Grading

The second component to this teaching method is Standards-Based Grading (SBG). Readiness and inquiry are addressed by TBL, and productive failure and mastery are addressed by SBG.

SBG begins with a clear set of learning objectives for the course, which are shared with the student. Methods for constructing these follow Guskey and Bailey (2001) and Marzano and Haystead (2008). The instructor must be transparent about what is to be expected, and what grade will be earned for meeting those expectations. In our case, we had 38 learning objectives, which are listed in the Appendix.

We chose to have standards assessments every 2 weeks. On an assessment day, each student was provided a folder that listed all possible objectives, and contained problems to be completed, covering all objectives up to that point. Objectives were graded on a ✓ or × basis. A ✓ indicated that the work satisfied the desired learning objective. An × indicated that the work was not satisfactory, and indicated that the problem was to be attempted again. The student folder also contained a spreadsheet with the instructor's signature next to each satisfied objective. Once an objective was satisfied on two separate occasions, it was considered mastered. On each assessment, a student would only attempt problems they had not yet mastered.

In order to make the failure to meet an objective productive, students had the opportunity to revise and resubmit their work. This could be done two ways. The first is that each learning objective covered in the course appeared on each standards assessment. Therefore, even if a student missed an objective on an early assessment, that objective would remain on all subsequent assessments. The second was to use a Revision Request form. This is located in the Appendix. A Revision Request required that the student visit the instructor in office hours. Prior to the appointment, the student was to have revised the missed work, and written a statement explaining both their misunderstanding of the original problem, and what they had done to learn from the mistake. A student who had done this was given a new problem, to be done at the board in front of the instructor.

Successful completion of this board work resulted in the grade change from × to ✓.

Students were provided with a great deal of sample and practice problems to assist them in mastering the content, but none of this work was required to be submitted for a grade. The students were forced to be accountable for their own learning, and to make the decision to prepare for the assessments, and to learn from their failures.

RESULTS

Calculus Understanding

Over the course of the semester, student scored an average of 7.2 on the iRATs and 8.7 on the tRATs. The individual scores rose from an average of 6.3 on the first assessment to 8.6 on the final assessment. Team scores rose from 8.1 to 9.4 in the same time period. Students seemed to become more proficient at reading the course material, and preparing for the assessments. The average student mastered 79% of the course objectives fully.

Unfortunately, only full mastery was recorded, so data on partial mastery is not available. This oversight will be corrected in future data collection. 10% of the students did not pass the course. Among students who did pass the course, 84% of course objectives were mastered.

Students self-reported engagement

Overall, the method appeared successful to the instructor. Student engagement was high, attendance was nearly perfect, and student feedback at the end of the term was primarily positive. The instructor is currently using the method a second time, with revisions as suggested by the students from the first iteration. A selection of positive and constructive student comments are included in the appendix. Anecdotal evidence from the instructor of the Calculus II course during the following semester indicated that the students who had used the TBL/SBG approach were well prepared to succeed.

As a whole, the method improves student engagement, encourages active learning, and teaches a variety of soft skills outside of just the course content. It is the instructor's intention to continue using this method. We would like to gather data in the future on the performance of students in future courses. We would also like to gather data on student's mathematics anxiety and mathematical self-efficacy, to study how this is affected by our method.

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Appendix A

Example Syllabus

CALCULUS I

This syllabus is subject to revision. All changes will be posted in the learning management system, and will be communicated to students via email.

Course Description: Limits, continuity, the derivative and its applications, and the integral and its applications.

Learning Outcomes: At the completion of this course, students will be able to:

1. Understand the concept of a limit, and compute limits of functions.
2. Understand the concept of a derivative, and be able to compute the derivatives of various functions.
3. Apply limits and the derivative to applications in physics and engineering.
4. Understand the concept of an integral, and be able to compute the integral of various functions.

- **Standards Assessments**: At the end of each two-week module, you will have a standards assessment. These are chances for you to demonstrate that you fully grasp a learning objective of the course. Standards will be graded as Correct (✓) or Incorrect (×). There are 38 learning objectives in the course. All standards covered up to that point in the course will be available on each assessment. You may choose which problems you complete. Each objective must be completed twice, on separate assessments, in order to count as mastered. Certain more complicated problems may count as covering multiple objectives.

- **Team-Based Learning**: This course will be using a team-based learning (TBL) approach. TBL encourages self-directed learning and will help teach you how to apply what you learn in a collaborative environment. TBL requires you to be prepared for and attend classes. Using the TBL method will allow us to avoid long lectures so that we can dig into the more complicated business of critical thinking about what we are learning. The course components will include the following:

- **Readiness Assessments (RA)**: At the beginning of classes where there is an assigned reading due, we will have a closed-note Readiness Assessment (10 items). You will take this RA twice; you will complete it once as an individual (iRA), and then as a team (tRA). These quizzes will be scored immediately so you can appeal your scores on the RA if you believe the key is wrong or there is another correct answer listed. If you are absent, you will receive a zero for both the iRA and the tRA for that day; however, I will also drop your lowest iRA and tRA at the end of the year, so you can miss one without penalty. I do not allow makeups for these assessments.
- **Team Activities:** In most classes, we will have one or more application activities where you will need to work with your team to devise the best solution or approach to a selection problem. You will not need to work on these assignments outside of the classroom, although completing the required readings will be imperative for your success on these assignments. The grading for this will assess whether you have appropriately applied key concepts you've learned to the problem. You will sign in to a sheet with your team each day to indicate that you've completed the Activity. Each daily activity is worth 3 points.

- **Peer Evaluations:** Twice during the course, you will complete a peer review. These will be anonymous, but they will be shared with your teammates. The goal of this review is to give you an opportunity to provide constructive feedback to your team members. Your average rating on the second review will serve as a multiplier on your team performance score. If you do not complete the reviews, you receive a score of zero for your own review, which will lead to a failing grade in the course.

Grading

Desired Grade	Objectives Mastered	Desired Grade	Objectives Mastered
A	35	**C**	27

A-	34	**C-**	26
B+	33	**D+**	25
B	31	**D**	23
B-	30	**D-**	22
C+	29	**F**	≤ 22

There are a total of 196 points available for Readiness Assessments and Team Activities.

Grades are capped at the team score percentage (90% for an **A**, 80% for a **B**, etc.). A student whose team grade exceeds their standards grade, will have their grade raised by 1/3. For example, if a student mastered 33 objectives, but scored over 90% on the team grade, that student would receive an **A-**. On the other hand, if a student mastered 35 objectives, but only scored 70% on the team grade, that student would receive a **C**.

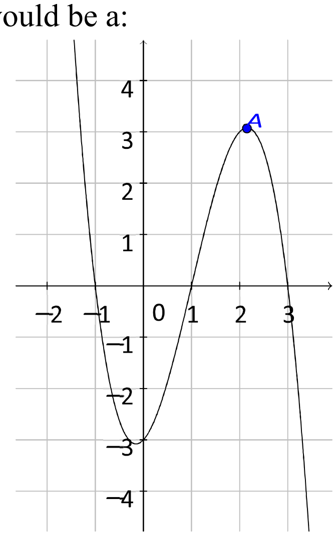
Appendix B
Learning Objectives

1. Evaluate a limit using the limit laws.
2. Evaluate a limit at infinity.
3. Evaluate an infinite limit.
4. Use limits to determine the horizontal and vertical asymptotes of a function.
5. Show, via the definition, that a function is continuous at a point.
6. Apply the Intermediate Value Theorem to show a function has a zero on a given interval.
7. Calculate the derivative of a polynomial function directly from the definition.
8. Calculate the derivative of a polynomial function using the power rule.
9. Calculate the derivative of a trigonometric function.
10. Calculate the derivative of a function using the product rule.
11. Calculate the derivative of a function using the quotient rule.
12. Calculate the derivative of a function using the chain rule.
13. Calculate the derivative of a function using a combination of the power, product, quotient, and/or chain rule.
14. Find the equation of a tangent line to a curve at a given point.
15. Correctly find the derivative of an implicit function.
16. Correctly set up a problem involving at least two related rates.
17. Solve a problem involving at least two related rates.
18. Identify the intervals on which a function is increasing and/or decreasing.

19. Identify the intervals on which a function is concave up and/or concave down.
20. Find all critical values of a function.
21. Use the 1st derivative test to classify extrema of a function.
22. Use the 2nd derivative test to classify extrema of a function.
23. Apply the Extreme Value Theorem to a problem.
24. Apply the Mean Value Theorem to a problem.
25. Correctly set up an optimization problem using the methods of Calculus.
26. Solve an optimization problem using the methods of Calculus.
27. Calculate an antiderivative of a polynomial function.
28. Calculate an antiderivative of a trigonometric function.
29. Use a finite summation to approximate the area under a curve.
30. Calculate a definite integral using the Riemann Sum.
31. Evaluate a definite integral using the Fundamental Theorem of Calculus.
32. Evaluate an indefinite integral.
33. Evaluate an indefinite integral using substitution.
34. Calculate the derivative of a logarithmic function.
35. Calculate the derivative of an exponential function.
36. Calculate a derivative using logarithmic differentiation.
37. Calculate the derivative of an inverse trigonometric function.
38. Evaluate a limit using L'Hospital's rule.

Appendix C Example
Readiness Assessment

1. The point A on this graph would be a:



(a) Local maximum
(b) Local minimum
(c) Absolute maximum
(d) Absolute minimum

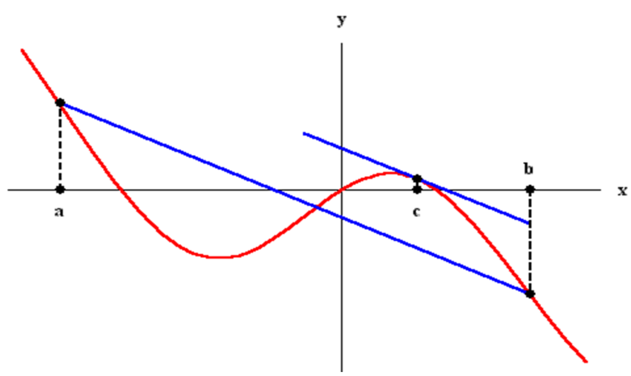
2. At any point where a function is increasing, the derivative must be:
(a) Zero
(b) Non-existent
(c) Negative
(d) Positive

3. The Extreme Value Theorem can be used to find out what information?
(a) The absolute max/min of a function, for all values.
(b) The derivative of a function
(c) Where a function is continuous.
(d) The absolute max/min of a function, on a closed interval.

4. The Extreme Value Theorem has a familiar hypothesis about which kind of function it can apply to. What is that hypothesis?
(a) The function must be increasing.
(b) The function must be decreasing.
(c) The function must be continuous.
(d) The function must be differentiable.

5. A critical number of a function f is a number c in the domain where which of these happens?
(a) The function is differentiable at c.
(b) $f'(c) = 0$.
(c) The function is not defined at c.
(d) $f'c) = 0$, or it does not exist.

6. The following image is often shown with the Mean Value Theorem. What can we assume about the derivative of the function f when $x = c$ and the slope of the line connecting the points where $x = a$ and $x = b$?



(a) The derivative is zero when $x = c$.

(b) All values of the derivative exist between a and b

(c) There is a local maximum when $x = c$

(d) The derivative at $x = c$ is the same as the slope of the line from $x = a$ to $x = b$.

7. What happens at a point of inflection?

(a) The function has a local maximum.

(b) The function has a local minimum.

(c) The graph changes concavity.

(d) The graph changes from increasing to decreasing.

8. Which of these would be described as an optimization problem?

(a) Find the relationship between the change in volume of a sphere and the change in its radius.

(b) Proving a real zero of an equation exists over a certain interval.

(c) A business owner wanting to maximize profits and minimize costs.

(d) Finding the slope of the tangent line to a curve at a specific point.

9. Optimization problems always require that we find which of the following?

(a) Absolute maximum or minimum of a function.

(b) Local maximum or minimum of a function.

(c) Intervals where a function is increasing or decreasing.

(d) Intervals where a function is concave up or concave down.

10. At any point where a function is decreasing, the derivative must be:

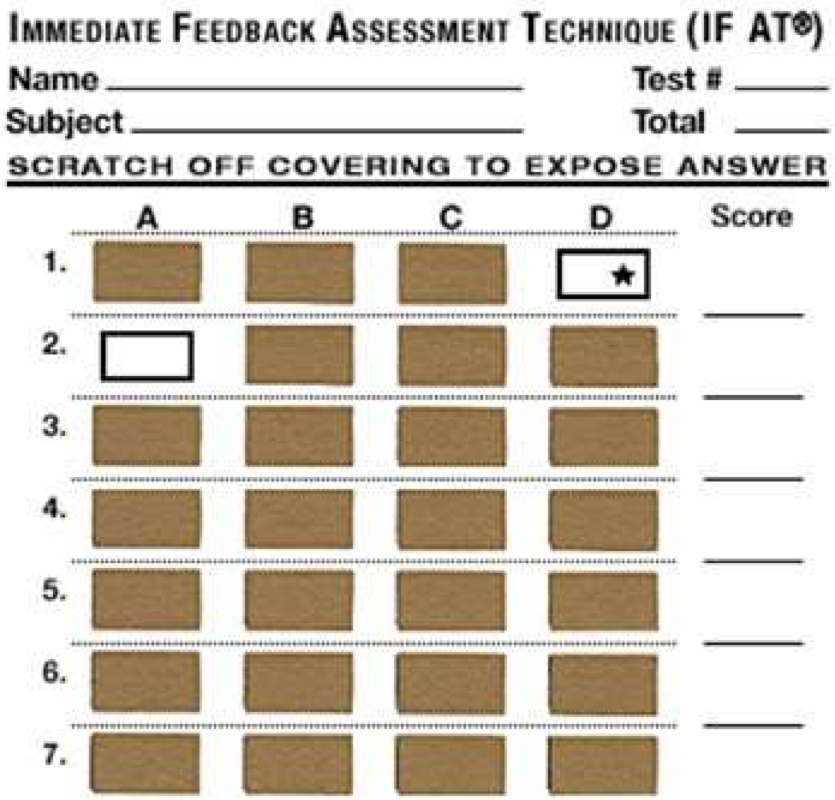
(a) Zero

(b) Non-existent

(c) Negative

(d) Positive

Appendix D IF-AT and ZipGrade Answer Sheets



IMMEDIATE FEEDBACK ASSESSMENT TECHNIQUE (IF AT®)

Name ________________ Test # ____

Subject ________________ Total ____

SCRATCH OFF COVERING TO EXPOSE ANSWER

	A	B	C	D	Score
1.				★	
2.					
3.					
4.					
5.					
6.					
7.					

Name	
Date		Period	

	A	B	C	D	E		A	B	C	D	E
1	◯	◯	◯	◯	◯	11	◯	◯	◯	◯	◯
2	◯	◯	◯	◯	◯	12	◯	◯	◯	◯	◯
3	◯	◯	◯	◯	◯	13	◯	◯	◯	◯	◯
4	◯	◯	◯	◯	◯	14	◯	◯	◯	◯	◯
5	◯	◯	◯	◯	◯	15	◯	◯	◯	◯	◯
6	◯	◯	◯	◯	◯	16	◯	◯	◯	◯	◯
7	◯	◯	◯	◯	◯	17	◯	◯	◯	◯	◯
8	◯	◯	◯	◯	◯	18	◯	◯	◯	◯	◯
9	◯	◯	◯	◯	◯	19	◯	◯	◯	◯	◯
10	◯	◯	◯	◯	◯	20	◯	◯	◯	◯	◯

Test Version: A ◯ B ◯ C ◯ D ◯

Get this form and more at: ZipGrade.com

Appendix E

Sample Team Activities

Applying Differentiation Techniques

1. How do we find the equation of the tangent line to a curve at a point?
   - First, make sure the team recalls the point-slope formula for the equation of a line. We should be able to find the equation of a straight line using only the slope, and some arbitrary point on that line.
   - Given the curve $y = x^2$, what is the equation of the tangent line when $x = 3$?
   - Given the curve $f(x) = \sin(x) - \cos(x)$, find the equation of the tangent line at the point (0,-1).
2. How do we linearly approximate functions with a derivative?
3. Suppose we want to find the approximate value of $\sqrt[3]{8.03}$
   - Can we find the exact value of $\sqrt[3]{8.03}$without a calculator?
   - Find the equation of the tangent line to the curve $y = \sqrt[3]{x}$ when $x = 8$.
   - Find the value of the point on this tangent line when $x = 1.03$. Compare this to the result on your calculator for finding $\sqrt[3]{1.03}$.
4. How could we use this idea to find an approximate value for $\sqrt[3]{31.94}$?
5. Can we use the tangent line to help approximate a zero of a function?
   - Start with the equation $x^3 + 2x - 1 = 0$.
   - It's tough to find an exact solution to this. First, show that the function $f(x) = x^3 + 2x - 1$ has at least one real zero on the interval $[0,1]$.
   - Find the equation of the tangent line to the function $f(x)$ when $x = 1$. We'll need some notation, so let $x_0 = 1$
   - Where does that tangent line cross the x-axis? Label that point x_1.
   - Now find the equation of the tangent line to the curve when $x = x_1$. Where does that line cross the x-axis? Label that point x_2.
   - If you were to keep doing this, make a conjecture about what would happen with the sequence of points $x_0, x_1, x_2, \ldots$.

Appendix F

Sample Standards Assessment

1. Possible Objectives: 1

Evaluate the limit, or determine that it does not exist.

$$lim_{x\to 2}\frac{x^2+6x+8}{x+2}$$

2. Possible Objectives: 2

Evaluate the limit, or determine that it does not exist.

$$lim_{x\to \infty}\frac{x^2+5x-1}{5x^2+4}$$

3. Possible Objectives:1, 3

Evaluate the limit, or determine that it does not exist.

$$lim_{x\to 3}\frac{2x}{3-x}$$

4. Possible Objectives: 1,2,3,4

Use limits to find all vertical and horizontal asymptotes of this function.

$$f(x)=\frac{3x^2-4}{2x^2-2}$$

5. Possible Objectives:1, 5

Use the definition to show that the given function is **not** continuous at the point $x = 1$.

$$f(x)=\begin{cases}2x+1\ if\ x\neq 5\\ 3\ if\ x=5\end{cases}$$

6. Possible Objectives:6

Apply the Intermediate Value Theorem to show that the function has a root in the interval [0, π]. State any hypothesis you use.

$f(x) = \cos(x)$

7. Possible Objectives:1, 7

Find the derivative of the following function, using the limit definition.

$f(x) = 5 - 2x$

8. Possible Objectives: 8

Find the derivative of

$$y=\frac{2x^2}{x^{1/2}}$$

without using the quotient rule.

9. Possible Objectives: 9 Given $y = \sec(\theta)$, find $\frac{dy}{d\theta}$.
10. Possible Objectives: 8, 9, 10

Find the first derivative of

$$f(x) = \tan(x)(3x - x)$$

11. Possible Objectives: 8, 9, 11

Find the first derivative of

$$f(x) = \frac{\tan(x)}{3x-5}$$

12. Possible Objectives: 8, 9, 12

Find the first derivative of

$f(x) = \tan(3x\ 5)$

13. Possible Objectives: 8, 9, 10, 11, 12, 13 Find the first derivative of

$$f(x) = \frac{\tan(3x^2)(2-\sqrt{x})}{\cos(x+5)}$$

14. Possible Objectives: 8, 9, 10, 11, 12, 13, 14

Find the equation of the tangent line to the curve $y = x^3 + \cos(x)$ at the point $x = 0$.

15. Possible Objectives: 8, 9, 10, 11, 12, 13, 15

Find $\frac{dy}{dx}$ for $xy = 2y^3$

16. Possible Objectives: 8, 9, 10, 11, 12, 13, 15, 16, 17

A 15 foot ladder is resting against the wall. The bottom is initially 10 feet away from the wall and is being pushed towards the wall at a rate of 1/4 ft/sec. How fast is the top of the ladder moving up the wall 12 seconds after we start pushing? (Note that this can count for objectives 16 and 17. Be very clear with your setup)

Appendix G

Selection of Student Feedback

- Was completely honest and consistent with the goal to understand how we know what we learned versus being able to get an answer. Understanding the method was more important than finding the most simplified answer. It left me understanding how and why we made the computations we did.
- The team based learning was much more effective for me than any other strategy used on me before.
- I would say this style of learning was not very rigorous in comparison to the other classes, but I feel like I learned the material I needed to. I am worried about making the shift next semester back to a normal learning style.
- I liked the core objectives and supplemental objectives sheet so we could clearly see what we have accomplished and what we need to work on.
- At the beginning of the course I was confuse and didn't understand a lot of the stuff we were doing, but after going to office hours and asking for help, my grade improve.

- I can really see why the way my instructed teaches the class is helpful. I liked the groups and the backward class style.
- I like the group set up of things, but mini lectures with examples when introducing a new topic would be helpful
- I like the style of having second chances on standards tests. It allows me as a student to focus on learning versus stressing about a perfect score on a test.
- Very good course. Much better taking calculus this time with the team based approach. The class is set up very nicely.
- The team based learning was a great idea, I liked bouncing ideas off of one another and there was usually someone in the group that understood what was going on if nobody else didn't.