

# Coding Calculus

*How Students Derive and Integrate with Coding  
(Project Explanation)*

**Session Slides: [bit.ly/NCTMCodingCalculus](https://bit.ly/NCTMCodingCalculus)**

**Before the session starts.**

- Go to [PollEv.com/emilymcdonal702](https://PollEv.com/emilymcdonal702) or QR
- *Question:* On a scale of **1-no experience** to **5-very experienced**, what is your experience level with Google Sheets and Google Apps Script?



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# Coding Calculus

**How Students Derive and Integrate with Coding  
(Project Explanation)**

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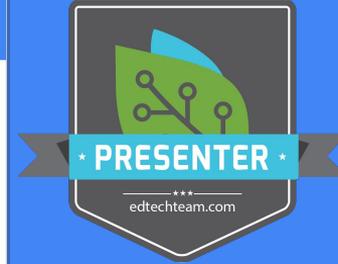
## Session Information:

***Recommended Audience:*** High School (Calculus)

***Time:*** 8:00 - 9:00 AM

Learn how students coded in high school Calculus using Google Apps for Education. For this project, students created a program/code that computed the derivative and integral of a polynomial function using Google Sheets and Google Apps Script with the push of a button. Learn how to implement this project and experience the process as a student.

It is recommended for participants to bring a device.



## Emily McDonald

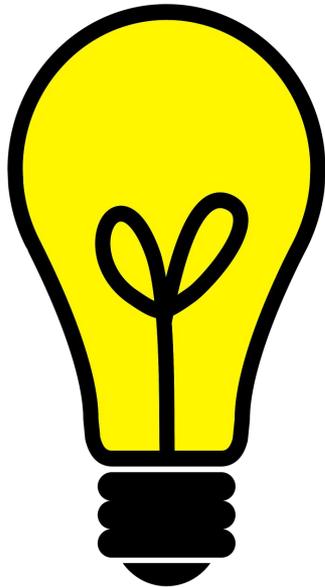


- Currently teaches Algebra 2 and Pre-Calculus
- This project completed at previous school.
- District is 1:1 with Chromebooks
- Idea inspired after a district Micro:Bit training
- Project first started Fall 2019. Continued through 2023.



Different experiences during this session.

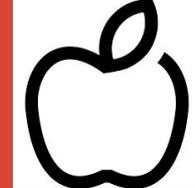
Student



Teacher



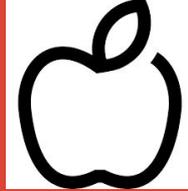
**Learning Target:** I can apply the properties of differentiation and integration to create a code using Google Sheets and Google Apps Script to differentiate and integrate a polynomial function.



Completed in four phases, a reflection, and group summary.

- **Phase 1:** Graph the derivative and integral approximation of a function using Google Sheets. [Link to Instructions](#)
- **Phase 2:** Introduction to Google Apps Script with basic code and brainstorm program setup. [Link to Brainstorm Coding](#)
- **Phase 3:** Use Google Apps Script in Google Sheets to create a button, text box, and evaluate a polynomial function.
  - [Link to instructions](#) for button and text-box
  - [Link to instructions](#) for custom functions
  - [Teacher Example](#) - Google Sheet
- **Phase 4:** Create a code using Google Apps Script to differentiate and integrate a polynomial function from a Google Sheet. [Link to scaffolded instructions](#)

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**Reflection:** Students had the option to reflect on the project using any of the following:

- Timeline: Sutori (website)
- Tutorial: iorad - the tutorial builder (Chrome Extension)
- Video Summary: Flipgrid

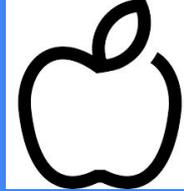
**Group Summary** - Work in groups to summarize the following:

- Derivative
- Integral
- Google Sheet
- Google Apps Script
- Benefits and drawbacks of the graphing methods for deriving and integrating

# Teacher Reflection: What was most successful?



- This project highlighted many **students' strengths in coding and exposed other students to coding** and G Suite tools (Google Sheets and Google Apps Script) for the first time.
- This project was also successful in utilizing and maximizing the use of technology. The **reflection component allowed students choice** and the group component **allowed students to collaborate on their project and improve their code** (if needed).
- The interactive component of the ROAR (Reflections of Outstanding Academic Rigor) display was successful in helping the public understand the project and engage with the docents.

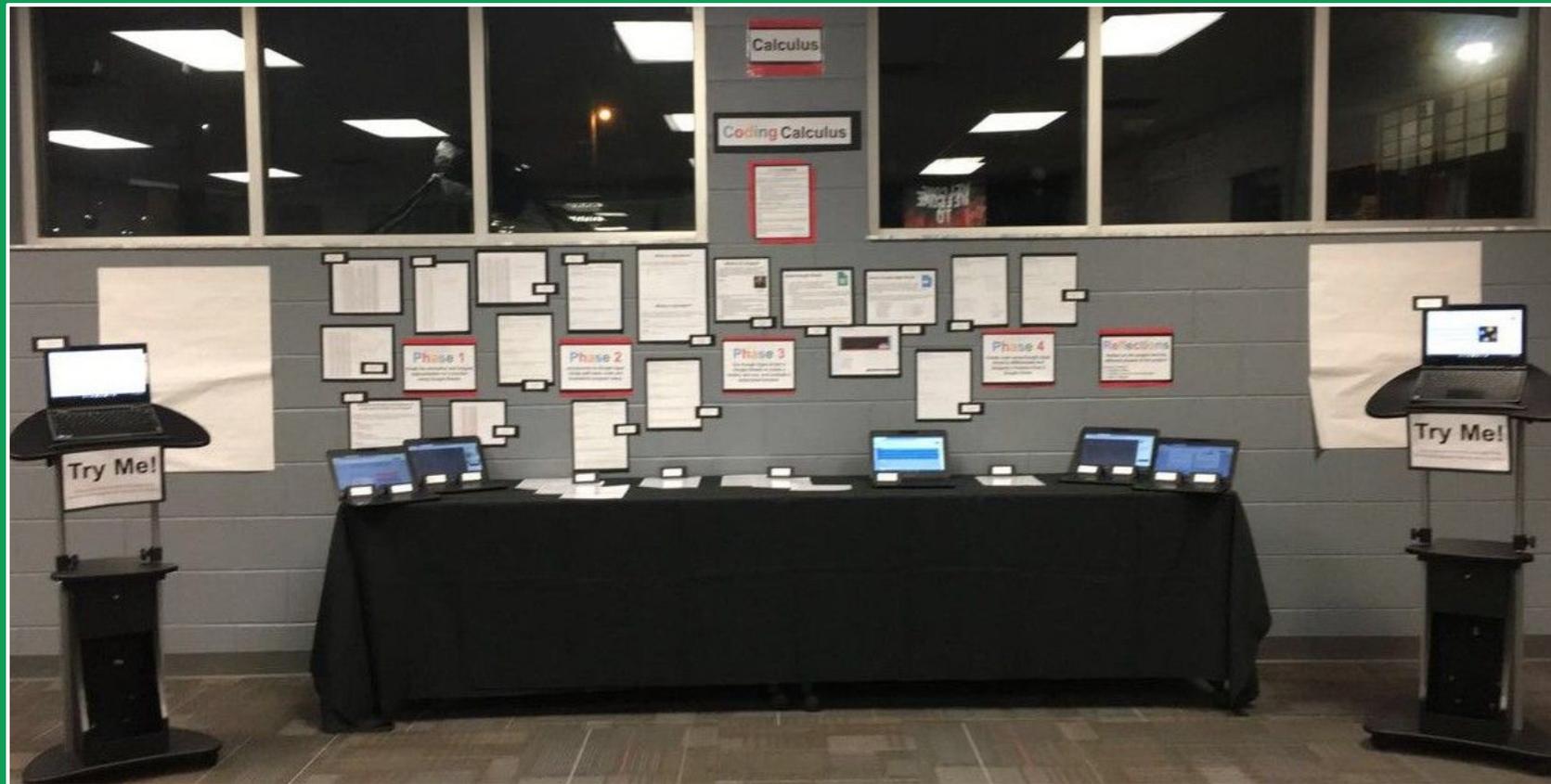


## Addressed the following TN Standards for Calculus (as of 2022):

- C.D.CD.A.1 Represent and interpret the derivative of a function graphically.
- C.D.AD.A.2 Calculate the derivative of basic functions (power, exponential, logarithmic, and trigonometric).
- C.D.AD.A.3 Calculate the derivatives of sums, products, and quotients of basic functions.
- C.I.UI.A.3 Use Riemann sums and trapezoidal sums to approximate definite integrals of functions represented graphically, numerically, and by tables of values.
- C.I.UI.B.7 Apply basic properties of definite integrals.
- C.I.AI.A.1 Develop facility with finding antiderivatives that follow directly from derivatives of basic functions (power, exponential, logarithmic, and trigonometric).

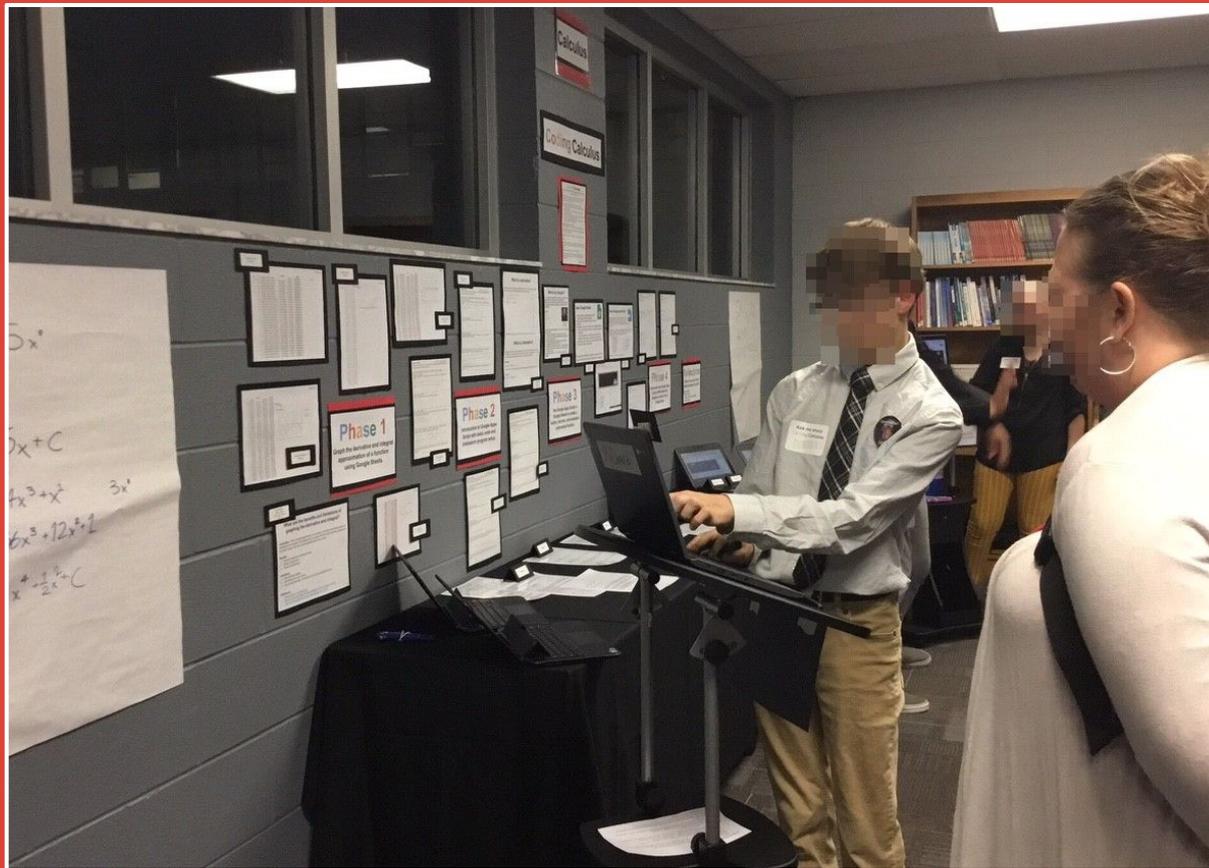
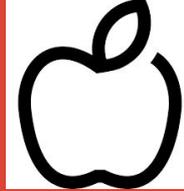
# Red Bank High School ROAR Night, Fall 2019

(Reflections of Outstanding Academic Rigor)



# Red Bank High School ROAR Night, Fall 2019

(Reflections of Outstanding Academic Rigor)



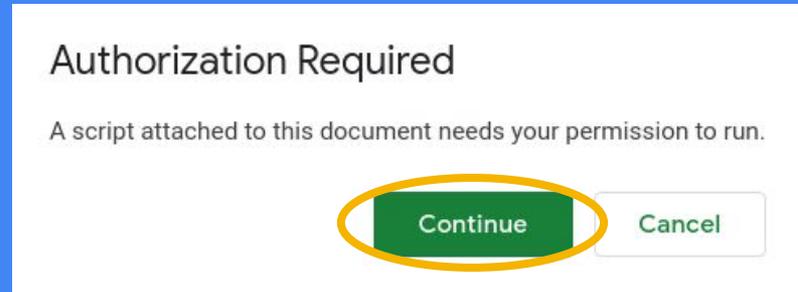
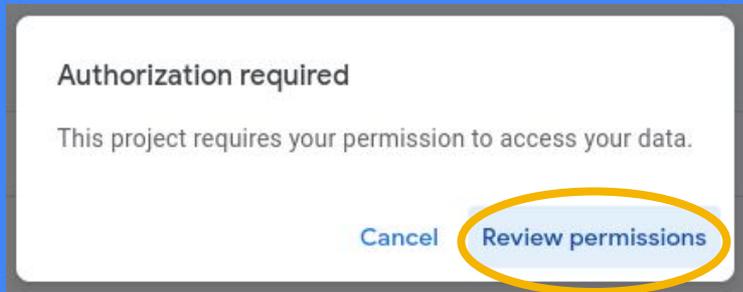
## Phase 3: Use Google Apps Script in Google Sheets to create a button, text box, and evaluate a polynomial function.



[CLICK HERE](#) to open an example Student Google Sheet

### Teacher Resources:

1. Button and text-box
  - Teacher Instruction Sheet: [Link to Google Doc](#)
2. Custom functions - Celsius Converter
  - Teacher Instruction Sheet: [Link to Google Doc](#)



**Phase 4: Create a code using Google Apps Script to differentiate and integrate a polynomial function from a Google Sheet.**

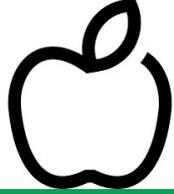


**CLICK HERE** to open an example Student Google Sheet  
*(same link as previous slide)*

Teacher Resources:

1. Scaffolded Instructions: [Link to Google Doc](#)

# Links to Student Work Examples, Fall 2019



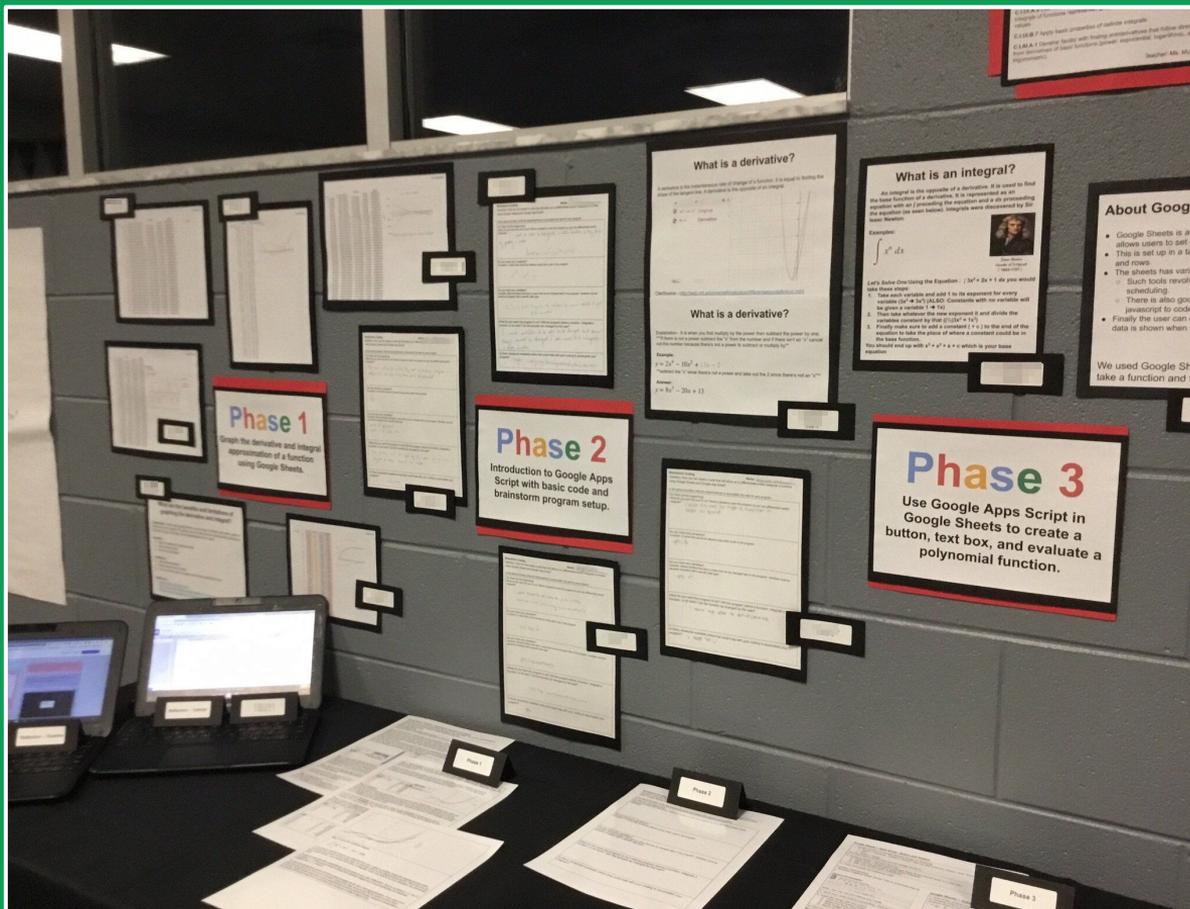
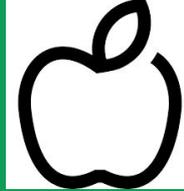
## Project:

- [Student 1](#)
- [Student 2](#)
- [Student 3](#)

## Project Reflection:

- [Student 3](#)
- [Student 4](#)

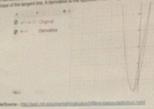
# Additional Pictures of Student Work, Fall 2019



### What is a derivative?

A function is the instantaneous rate of change of another function. It is used to finding the slope of the tangent line to the curve at the location of the tangent.

$f(x) = x^2$  Derivative



What is a derivative?

It is when you are asked to find some function given by the letter 'f'. You have to find some value like 'f' from the number and if they are not 'f' you can't do anything because they are given to calculate 'f'.

Example:

$$f(x) = x^2 \Rightarrow f'(x) = 2x$$

Example:

$$f(x) = 3x^2 - 20x + 13$$

### What is an integral?

An integral is the opposite of a derivative. It is used to find the area under the curve of a function. It is represented as  $\int$  and the function to be integrated is written as  $f(x)$ . The result of the integral is written as  $F(x)$ .

Example:

$$\int x^2 dx = \frac{x^3}{3} + C$$

Let's Solve One Using the Equation:  $3x^2 + 2x + 1$  do you want to solve these equations?

1. Take each variable and add 1 to the exponent for every variable.  $3x^2 + 2x + 1$  becomes  $3x^3 + 2x^2 + 1x$  and we have to give a constant  $+ C$ .
2. Then take the derivative of the new equation and divide the derivative by the original equation.
3. Finally make sure to add a constant  $+ C$  to the end of the equation to take the place of where a constant would be in the base function.

The final result is  $\frac{1}{3}x^3 + \frac{1}{2}x^2 + x + C$  which is your base equation.

### About Google

- Google Sheets is a spreadsheet tool that allows users to set up spreadsheets in tables and rows.
- The sheets has various features like scheduling, formulas, and macros.
- There is also google apps script to code a spreadsheet.
- Finally the user can download the data when they want.

We used Google Sheets to take a function and find its derivative.

# Additional Pictures of Student Work, Fall 2019



B	C	D	E	F	G	H	I	J	K
---	---	---	---	---	---	---	---	---	---

- Step 1: Input your function by typing the coefficients on the "Input" row of the chart.  
Step 2: Press the button on the bottom left corner to derive and integrate the function.  
Step 3: Review your function and the outputs in the box next to the button.

**\*For fractions, use "=DEVIDE(a, b)"**

	Sextic Coefficient	Quintic Coefficient	Quartic Coefficient	Cubic Coefficient	Quadratic Coefficient	Linear Coefficient	Constant
Input		0	-5	8	-12	0	3
Derivative			0	-20	24	-24	0
Integral	0	-1	2	-4	0	3	C



$f(x) = -5x^4 + 8x^3 - 12x^2 + 3$
$d/dx[f(x)] = -20x^3 + 24x^2 - 24x$
$\int f(x) dx = -1x^5 + 2x^4 - 4x^3 + 3x + C$

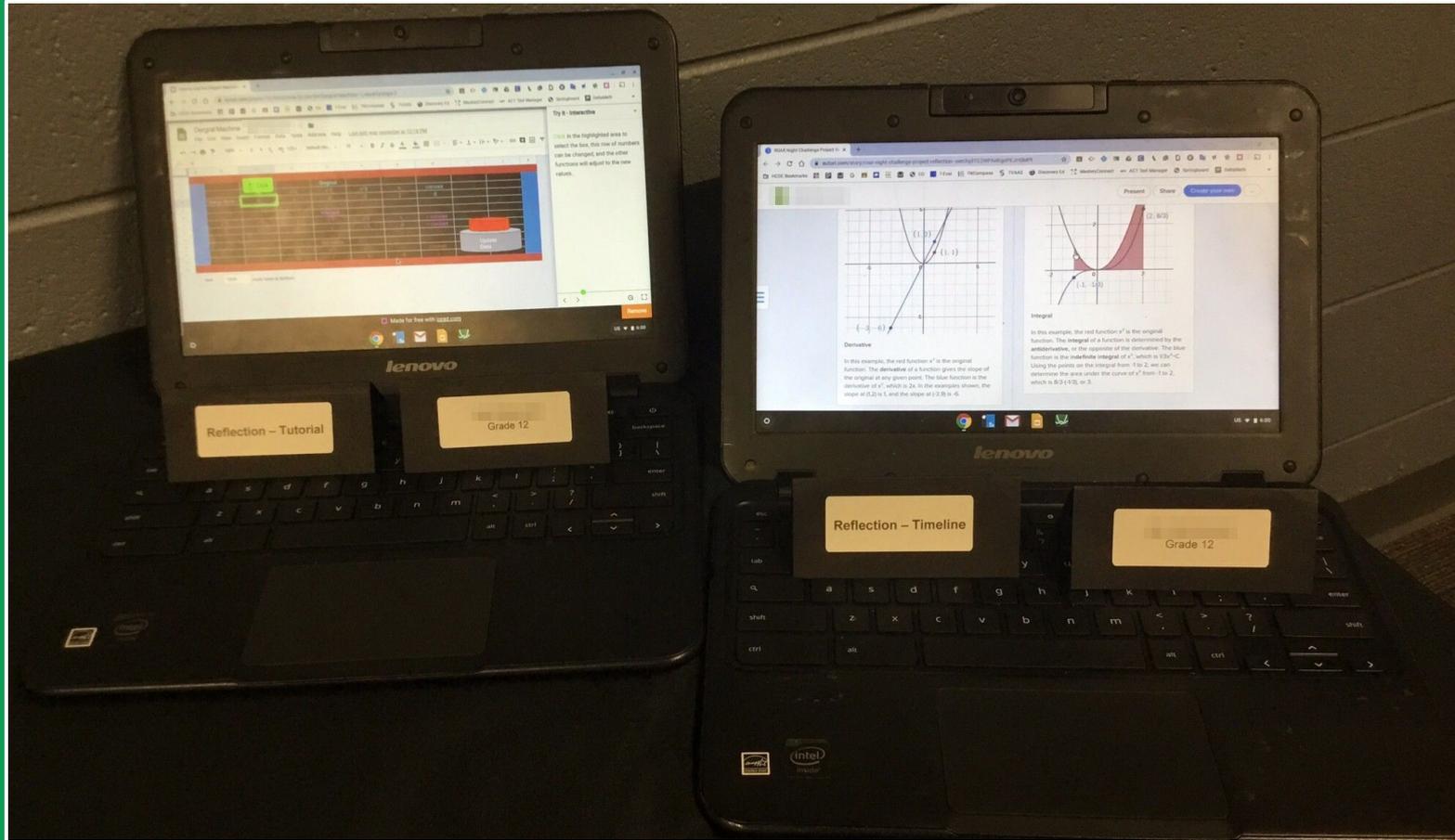
# Additional Pictures of Student Work, Fall 2019



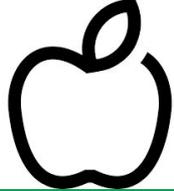
Code.gs x

```
1 function deriveAndIntegrate() {
2   var sheet = SpreadsheetApp.getActiveSpreadsheet()
3   var n5 = sheet.getRange('E4').getValue()
4   var n4 = sheet.getRange('F4').getValue()
5   var n3 = sheet.getRange('G4').getValue()
6   var n2 = sheet.getRange('H4').getValue()
7   var n1 = sheet.getRange('I4').getValue()
8   var nc = sheet.getRange('J4').getValue()
9
10  sheet.getRange('F5').setValue(n5*5)
11  sheet.getRange('G5').setValue(n4*4)
12  sheet.getRange('H5').setValue(n3*3)
13  sheet.getRange('I5').setValue(n2*2)
14  sheet.getRange('J5').setValue(n1)
15
16  sheet.getRange('D6').setValue(n5/6)
17  sheet.getRange('E6').setValue(n4/5)
18  sheet.getRange('F6').setValue(n3/4)
19  sheet.getRange('G6').setValue(n2/3)
20  sheet.getRange('H6').setValue(n1/2)
21  sheet.getRange('I6').setValue(nc)
22 }
```

# Additional Pictures of Student Work, Fall 2019

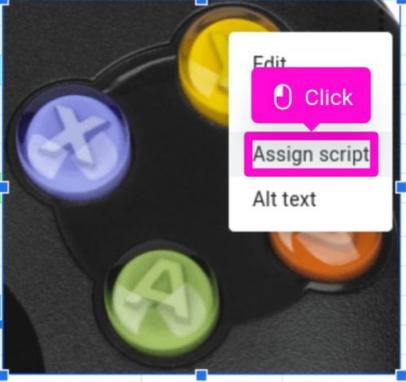


# Additional Pictures of Student Work, Fall 2019



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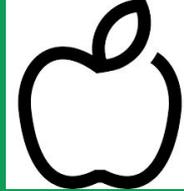
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$x^3$	$x^2$	$x$	Constant					
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# Additional Pictures of Student Work, Fall 2019

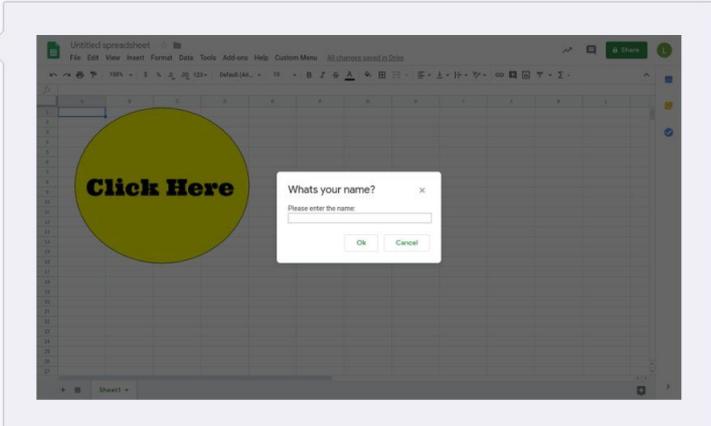
This is how I created a spreadsheet and computer code to produce the integral and derivative of a function.

The information was typed to create a basic integral and derivative graph. This was the basic intro to creating something within spreadsheets.

Step 3: Use Google Apps Script in Google Sheets to create a button, text box, and evaluate a polynomial

Step 1: Graph the derivative and integral approximation of a function using Google Sheets.

Step 2: Introduction to Google Apps Script with basic code and brainstorm program setup.



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#NCTMDC23

# Thank You!

## Any questions?

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