GENAI IN GATEWAY MATHEMATICS LEARNING



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genAI in Gateway Mathematics Learning

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1: INTRODUCTION

In this section, we describe the motivation for this work as well as how these activities were designed to be implemented.

1.1: Why genAI Literacy?
1.2: Course Deployment Suggestions
1.3: Why and How to Use Surveys

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1.1: Why genAI Literacy?

GenAI and its impact on education

If you have found this resource, you are likely familiar with generative artificial intelligence (genAI) and large language models (LLMs) and the ever expanding set of AI-related tools and systems that are anticipated to dramatically impact society in the 21st century. In education, the impact of LLMs in particular has been dramatic and swift. Educators have reacted to this in many ways, including adapting assignments, changing course structure, restricting LLM use, and redefining learning outcomes and curriculum more broadly.

The impact of LLM use and misuse on student learning is an ongoing topic of study and debate. What has become clear is that:

1. We cannot ignore the impact of LLMs and genAI more broadly in educational spaces.
2. LLM use by students is high but not a foregone conclusion, especially due to ethical concerns.
3. LLMs and genAI will be a part of many professions and industries our students encounter in their careers.
4. LLMs and genAI has the potential to impact society in substantial ways, which is tied to the core mission of educational institutions to develop not just a workforce but also to promote societal development and an educated citizenry.
5. Technology use impacts segments of society differentially.

This resource is a collection of activities that have been developed to address some of these concerns in gateway mathematics courses like calculus and pre-calculus or college algebra. Activities were designed to engage students in reflection about learning in the context of LLM outputs, teach students specific prompting skills, encourage students to explore LLMs from a learning perspective, and re-focus students on learning as the desired outcome (not just an answer). Each activity has a survey associated with it, which educators can use to understand the student experience better. We have also developed an instructor guide to accompany these materials.

The materials provided here should be thought of as a starting point, not an ending point, for any instructor--we encourage instructors to adapt and re-imagine these activities in new ways, as fits their classroom needs but also in recognition that LLMs and other technologies will evolve, as will our students. These activities represent a snapshot in time in some sense, but also a more generalizable approach of implementing scaffolded reflection into the classroom in order to re-focus on learning. Such reflection activities have a long history in education well before LLMs.

What courses are covered in these materials?

The materials provided here were developed for three gateway mathematics courses:

1. College Algebra/Precalculus
2. Calculus 1
3. Calculus 2

However, the conceptual framework could be applied in other courses.

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1.2: Course Deployment Suggestions

We suggest the following structure for instructors.

Beginning of course

1. Have an all-class discussion about genAI and LLMs with students at the very beginning of the course, making sure to get feedback from students during the discussion. This is critical to understanding how students may approach the worksheets.
2. Ask students about their AI use/familiarity/concerns as well as tech access in a survey to determine what the best approach is for this work.
3. Let students know whether they will need their own devices (laptops, smartphones, etc.) to do in-class work.

Worksheet deployment

Depending on the worksheet and content, the instructor may have already introduced the topic on the worksheet or use the worksheet as a way to introduce the topic. Here's what typically happens when instructors use the worksheets:

- Hand out worksheets on paper or electronically and explain why we are doing this. Some potential why's:
  - To learn how to learn and study
  - To learn the topic
  - To train ourselves on evaluating mathematical work and explanations
  - To familiarize ourselves with tools and systems they may encounter not just in this course but in other settings
- Allocate at least 20 minutes of in class time for students to work on worksheets in small groups of 2-3 students.
- At the end of each worksheet activity, individual students fill out a short reflection survey, which should take at most 5 minutes.
- Collect worksheets (on paper or electronically).

Note

There are 3 general types of worksheets provided:

1. Introduction worksheets, tied to exploring a textbook that has an embedded AI chat bot and one key review topic. **This should be modified to fit the needs of the course and its associated textbook.**
2. Course content worksheets. These are labeled by topic and should be broadly useful for a variety of courses. They typically ask students to select a genAI system to work with to explore a topic in a variety of ways, including:
   1. Creating practice problems.
   2. Generating common errors.
   3. Generating or describing graphs or graphical relationships.
   4. Explaining answers or concepts.
   5. Validating work.
3. A final review worksheet, which is co-authored with genAI. This activity provides a model for students in how they could creatively study for the course, via a long format application setting. The content is related to an economics application and **may need to be modified for a different audience**, but includes reflection activities that are relevant for study habits in general.

Close the loop

The instructor reviews through answers or the activity and what students should be thinking about as they navigate genAI systems, allowing space for students to share or ask clarifying questions.

Tips for Accountability

As with many other activities in the classroom, there are ways to ensure that students are more engaged. We suggest:

1. Providing participation credit for individual surveys as well as group worksheet completion to help ensure students are attempting the activity.
2. If you are able, walk around the classroom while students are working on the worksheets and ask them questions about what they are finding. You may learn something too!

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1.3: Why and How to Use Surveys

Surveys are provided as a way to enable:

- Students to do the **metacognitive work** of thinking about whether these activities helped them learn or not.
- Instructors to be able to **assess student understanding and perceived effectiveness** of the activity.

All surveys provided here are anticipated to be used for individual reflection (not group surveys). There are 3 general types of surveys:

1. **Introduction surveys**, tied to exploring a textbook that has AI features and a review topic. *This should be modified to fit the needs of the course and its associated textbook.*
2. **Course content surveys.** These should be disseminated *after* deploying the associated worksheet and *should not need to be modified for a particular course*, as long as the worksheet has not been changed significantly.
3. **A final review survey.** This is not a reflection on the associated worksheet, but rather a course experience and perceptions of learning survey. *This particular survey should be modified to fit the needs of the course.*

All surveys could be disseminated on paper or via other tools. Here, we are providing an electronic version of the questions as a model for your use, but we have also created a repository for copying surveys as a Google Forms (opens in new window), in case you wish to disseminate in that way.

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2: WORKSHEETS

Here we provide gen-AI infused worksheets, sorted by class and named by topic. Note that these worksheets ask students to use one of 5 general approaches with genAI:

1. **Conceptual exploration:** explanations of concepts or creative analogies.
2. **Error generation:** generate common errors students might make.
3. **Graphical interpretation:** generate graphs or explain graphs.
4. **Practice problems:** create topic-specific practice problems with specific course guidelines (such as ``use a variety of function types, but no trigonometry'').
5. **Validating work:** generate an answer to a question so the student can check their work.

2.1: College Algebra/Precalculus

2.1.1: General Problem Solving

2.1.2: Utilizing Inverse Functions

2.1.3: Linear vs. Exponential Functions

2.2: Calculus 1

2.2.1: Introduction to Piecewise Functions and Textbook

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2.2.10: AI-Assisted Optimization

2.2.11: Final Review Worksheet

2.3: Calculus 2

2.3.1: Introduction to Partial Fraction Decomposition and Textbook

2.3.2: Definite Integrals

2.3.3: Exponential and Logistic Growth Models

2.3.4: Integration by Parts

2.3.5: Work Integrals

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2.1: COLLEGE ALGEBRA/PRECALCULUS

In this section, we provide worksheets developed specifically for College Algebra/Precalculus courses, covering:

1. General problem solving, with an application to area
2. Inverse Functions
3. Linear and Exponential models

These were developed without trigonometry concepts, and are therefore applicable to a spectrum of college algebra/precalculus-type courses.

2.1.1: General Problem Solving

2.1.2: Utilizing Inverse Functions

2.1.3: Linear vs. Exponential Functions

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2.1.1: General Problem Solving

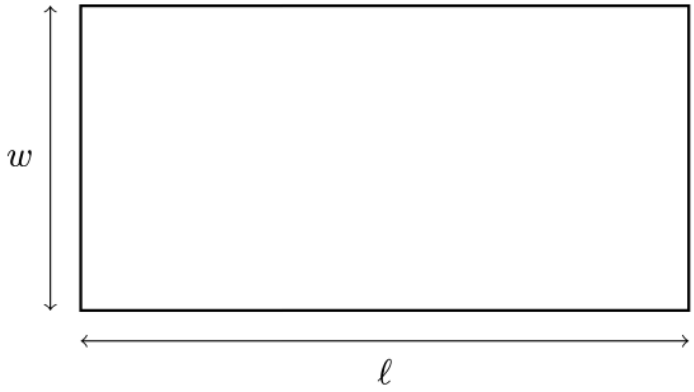
Objective

To explore problem solving techniques in an application setting, and use genAI to evaluate your work.

Each student will submit an individual completed worksheet at the end of class. We encourage you to work through this with a friend or two, though!

Designing a Cargo Storage Area with AI Support

You are tasked with designing a rectangular cargo storage area on a ship, depicted in the figure below. The total length of the boundary ropes used to enclose the storage area is 30 meters. The length of the storage area is 5 meters more than twice the width.



Determine the Dimensions

1. Write an equation for the perimeter of the storage area.

2. Solve the equation to find the dimensions of the storage area (width and length).

genAI Validation

1. Select an AI system (e.g., ChatGPT, Claude, Gemini) to check your solution. Which AI system did you use?
2. Prompt the AI system by inputting the problem in your own words, including the equation for the perimeter and the relationship between length and width.
3. Summarize the AI's response below and compare it to your manual solution.

4. Did the AI confirm your answer or suggest something different? Explain.

5. Challenge: If you add 4 meters to the length while keeping the total rope length the same, what will the new width be? Solve this on your own.

6. Use the AI system to solve this new problem. Provide the prompt you used below.

7. Compare the AI's solution to your calculations. Do they match? Explain.

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2.1.2: Utilizing Inverse Functions

To explore inverse functions, and how to use genAI to verify and interpret your work, in an application setting.

Directions

Each student will submit an individual completed worksheet at the end of class. We encourage you to work through this with a friend or two, though!

Navigation System Check

Your ship's navigation computer converts **distance** (in nautical miles) to **travel time** (in hours) using a function based on average speed. The function is $T(d) = \frac{d}{15}$ where d is distance traveled at 15 knots. One of your engineers wants a function that takes travel time and outputs distance.

Part 1. Manual Solution

1. Determine whether $T(d)$ has an inverse.

2. If it does, find the inverse function $T^{-1}(t)$.

3. Check that your inverse works by composing and simplifying:
    1. $T(T^{-1}(t))$

    2. $T^{-1}(T(d))$

Part 2. Checking with AI

1. Select an AI system (ChatGPT, Claude, Gemini, etc.) to verify and interpret your result. Write your AI system selection here:
2. To verify your answer, use the following prompt (but fill in what you found your inverse function to be):

Your Prompt to the AI

I found the inverse of T(d) = d/15 to be T^{−1}(t) = [fill in your answer here]. Please show the steps for finding the inverse and verify if my result matches yours.

3. What was the AI response? (paste below)

4. To interpret your answer, use the following prompt:

Your Prompt to the AI

Explain what an inverse function means in this real-world context of travel time and distance at a constant speed.

5. What was the AI response? (paste below)

6. Did the AI confirm your answers? YES/PARTLY/NO (circle one)

7. How similar or different were its explanations?

Part 3. Challenge Problem

The ship now changes speed based on current:

$T(d) = \frac{d}{15+2\sin(d)}$

1. Does this function have an inverse over all real numbers? Explain your thoughts (without consulting the AI system).

2. Use the AI tool to explore what conditions might allow an inverse, using the prompt below:

Your Prompt to the AI

The function T (d) = d/(15 + 2 sin(d)) represents variable speed. Explain whether this function has an inverse and, if not, describe intervals where it could.

3. Reflect on how AI handled reasoning about domains and restrictions. Did it reason symbolically or narratively? Was it correct?

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2.1.3: Linear vs. Exponential Functions

To explore linear and exponential functions and compare with genAI reasoning

Directions

Each student will submit an individual completed worksheet at the end of class. We encourage you to work through this with a friend or two, though!

Loading Cargo Over Time

A crane is loading containers onto a ship. The total weight of the loaded cargo is recorded at equal time intervals, as shown in the table below:

Time (hours)	Weight (tons)
0	0
1	5
2	10
3	15
4	20

Manual Solution

1. Plot the data points on a graph.

2. Describe the pattern of the data. Is the growth linear or exponential?

3. Write an equation to represent the relationship between time (x) and weight (y).

Fuel Consumption Over Time

A ship's fuel consumption rate is doubling every hour, as shown in the table below:

Time (hours)	Fuel Used (gallons)
0	1
1	2
2	4
3	8
4	16

Manual Solution

1. Plot the data points on the same graph as Problem 1. Is it logical to graph these data sets together? Explain your reasoning.

2. Describe the pattern of the data. Is the growth linear or exponential?

3. Write an equation to represent the relationship between time (x) and fuel used (y).

Comparing Models Over Time

We have two data sets from this scenario: the total weight recorded at equal time intervals and your ship's fuel consumption rate, which is doubling every hour. Let's compare.

Manual Solution

Compare the two graphs from Problems 1 and 2:

1. How does the growth differ between the two scenarios?

2. At what point does the fuel consumption exceed the weight of the cargo loaded?

3. Challenge: If the crane's loading speed doubles every hour instead of staying constant, how would the data change? Write a new equation to represent the scenario.

Check with AI

1. Select an AI system (ChatGPT, Claude, Gemini, etc.) to use. Write your AI system selection here:
2. Using the AI system, plot the data from Problems 1 and 2 and generate equations fitting the data using the following prompt:

Your Prompt to the AI

I have two data sets.
Set 1 (cargo weight): (0,0), (1,5), (2,10), (3,15), (4,20). Set 2 (fuel use): [fill in data manually here].
Please graph the two sets and give equations that represent the two sets.

3. What prompts did you enter? (copy/paste them)

4. What was the response of the AI? (paste below)

5. Did the AI confirm your answer? How similar or different was its explanation?

6. Reflect on how AI handled reasoning about linear and exponential models. Did it reason symbolically or narratively? Was it correct?

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2.2: CALCULUS 1

In this section, we provide worksheets developed specifically for Calculus 1 courses, covering:

1. Piecewise functions
2. The definition of the derivative
3. Implicit differentiation
4. Chain rule
5. Linear approximation:
    1. Drag force and velocity
    2. Google Search Data
6. Graphs and derivatives
7. Optimization
8. Applications:
    1. Marginal functions (an economic concept)
    2. Elasticity (an economic concept)
    3. Drag force and velocity (a physics concept)
9. A review activity

Many of these activities were developed for a calculus 1 course that did not require trigonometry and are therefore applicable to a spectrum of calculus 1-type courses.

2.2.1: Introduction to Piecewise Functions and Textbook

2.2.2: Definition of Derivative and Practice Tests

2.2.3: Exploring Implicit Differentiation in Economics

2.2.4: Chain Rule Exploration and Error Generation

2.2.5: Application- Understanding Marginal Functions

2.2.6: Linear Approximation in Velocity and Drag Force

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2.2.8: Understanding Graphs and Derivatives

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2.2.10: AI-Assisted Optimization

2.2.11: Final Review Worksheet

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2.2.1: Introduction to Piecewise Functions and Textbook

Objective

To explore piecewise functions, and how to use our course textbook.

Directions

Please form groups of around 3 for this activity. Each group will submit a completed worksheet at the end of class. Include the names of all group members above and clearly explain your answers below.

Questions

1. **Check In:** The absolute value function is a piecewise-defined function. Has anyone in your group learned this before?

2. **Graph:** the absolute value function is a "v"-shaped graph. Sketch its graph below.

3. **Discussion:** Why would a "v"-shaped graph be defined piecewise? Summarize your discussion below.

4. **Now, navigate** to our textbook section on Piecewise-Defined Functions.
5. **Checkpoint 1.14:** Find the problem labeled Checkpoint 1.14.
    1. Hover your cursor over the box for Checkpoint 1.14.
    2. Click on it to interact. You will see the chat bot activate to the right of the page.
    3. The chat bot wants to help you understand how to graph this function. Try asking it to graph the function for you. Does it graph the function for you?

4. Now, using the chat bot's help (if needed), graph the function described below.

Reflection

1. **Group reflection:** How does your group feel about piecewise functions? Graphing?

2. **Individual Reflection:** please fill out the worksheet activity survey before you leave class today.
3. **Turn in this worksheet.**

Both your survey response and turning in this worksheet will count for participation for today.

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2.2.2: Definition of Derivative and Practice Tests

To explore the definition of derivative, and how to generate practice problems for studying.

Directions

Each student will submit an individual completed worksheet at the end of class. We encourage you to work through this with a friend or two, though!

Questions

1. **AI system:** select an AI system that you want to try to use today for this activity (e.g. gemini, claude, chatGPT). Write your AI system selection here:
2. **Generating Questions:** Ask your AI system to generate 3 practice problems related to the definition of derivative that use a variety of functions, have varying difficulty, and include some conceptual ideas. Write or summarize the questions below:
   1.
   2.
   3.
3. **Critical evaluation:** Do these questions satisfy what we asked for? YES/NO (circle one)

   If not, prompt your system to rewrite the questions.

4. **Practice!** Find a partner or friend and imagine this is a group quiz scenario where you have 10 minutes to complete 1 of the 3 questions (it's your choice which one to choose). Write your answer below (everyone should write their answer on their own worksheet).
5. **Checking our work:** Ask your AI system for its answer to the problem. Does it match yours? How would you know which is correct?

Reflection

1. **Individual Reflection:** please fill out the worksheet activity survey before you leave class today.
2. **Turn in this worksheet.**

Both your survey response and turning in this worksheet will count for participation for today.

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2.2.3: Exploring Implicit Differentiation in Economics

Objective

To explore the concept of implicit differentiation through group collaboration and real-world applications in economics, as well as consider the creative potential for alternative explanations generated by AI systems.

Directions

Each group will submit a completed worksheet at the end of class. Include the names of all group members and clearly explain your work below.

Warm-Up Questions

1. What is the difference between explicit and implicit equations? Write your response in 2-3 sentences.

2. What role does the chain rule play in implicit differentiation?

Application to Economics - Revenue

1. Choose an AI system (e.g., ChatGPT, Gemini, or Claude) as a group and write which system you are using here:
2. Using your AI system, ask how revenue is defined. If it does not give you an equation, then ask it to do so.
3. Use this equation to find the derivative of revenue with respect to quantity. If you are stuck, ask the AI system to help you with the derivative!
4. Write down your findings below:
    1. Revenue is (write equation here):
    2. Derivative of revenue is:
5. Does this derivative involve implicit differentiation? If so, where?
6. **Creative or Alternative Explanations:** Ask your AI system to find a creative way to explain the implicit differentiation (e.g., analogy, visualization, story). Briefly summarize what your AI system came up with below:

Reflection

1. **Individual Reflection:** please fill out the worksheet activity survey before you leave class today.
2. **Turn in this worksheet.**

Both your survey response and turning in this worksheet will count for participation for today.

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2.2.4: Chain Rule Exploration and Error Generation

Objective

To explore the definition of derivative, and how to generate practice problems for studying.

Please answer the questions below. Each group will submit a completed worksheet at the end of class.

Questions

1. Select an AI system such as ChatGPT, Gemini, or Claude to use for this activity. Write down your choice here:
2. **Generating errors:** ask your AI system to generate 3 common errors students might make in applying the chain rule in calculus.

   Your Prompt to the AI

   Generate 3 common errors students might make in applying the chain rule in calculus. For each error, give a description and a specific math example.

   Write down each type/description and an example of such an error below:

   1. Description of error: _____

      ### Example

      Original function:

      Incorrect derivative:

      Correct derivative:

   2. Description of error: _____

      ### Example

      Original function:

      Incorrect derivative:

      Correct derivative:

   3. Description of error: _____

      ### Example

      Original function:

      Incorrect derivative:

      Correct derivative:

3. You diagnose the error!

1. Ask your AI to generate common errors specifically related to the chain rule.

   Your Prompt to the AI

   Give me an example of an incorrect derivative using the chain rule, but do not tell me why it is incorrect.

2. Write down the function your system gave you below:
3. Write down the incorrect derivative it gave you:
4. What is the error? (Is there one?)
5. Correct derivative:

Reflection

1. **Individual Reflection:** please fill out the worksheet activity survey before you leave class today.
2. **Turn in this worksheet.**

Both your survey response and turning in this worksheet will count for participation for today.

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2.2.5: Application- Understanding Marginal Functions

To explore the concept of implicit differentiation through group collaboration and real-world applications in economics, as well as consider the creative potential for alternative explanations generated by AI systems.

Each group will submit a completed worksheet at the end of class. Include the names of all group members and clearly explain your work below.

Warm Up Questions

1. 🔥**The Cookie Conundrum:** You're running a cookie business. It costs $50 to bake 100 cookies and $52 to bake 101 cookies. What is the cost of the 101st cookie? (Show your math below.)

2. **Key Definitions.** Fill in the blanks:
    1. **Marginal Cost (MC)** = the derivative of the _____ function
    2. **Marginal Revenue (MR)** = the derivative of the _____ function
    3. **Marginal Profit (MP)** = _____ – _____

Example: Baking Cookies with Math

You're given the following functions:

Cost: $C(x) = 0.01x^2 + 5x + 100$
Revenue: $R(x) = 15x$

Let x represent the number of cookies sold.

1. Find the marginal cost function:

    C'(x) =_____

2. Find the marginal revenue function:

    R'(x) = _____

3. Find the marginal profit function:

    P'(x) = _____

4. Evaluate at x = 100:

    C'(100) =

    R'(100) =

    P'(100) =

5. **Interpretation:** What does C'(100) tell you? Briefly answer.
6. **AI system:** select an AI system that you want to try to use today for this activity. AI system selected:
7. Ask the AI system to explain why marginal functions are useful in econ? Please summarize its response below.
8. Did its response align with your answer to #4 above? Why or why not?

Reflection

1. **Individual Reflection:** please fill out the worksheet activity survey before you leave class today.
2. **Turn in this worksheet.**

Both your survey response and turning in this worksheet will count for participation for today.

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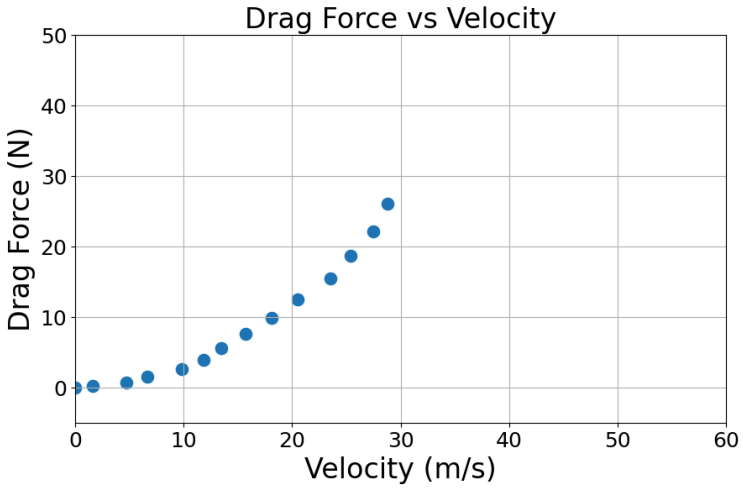
2.2.6: Linear Approximation in Velocity and Drag Force

To understand the concept and application of linear approximation through exploration, group collaboration, and real-world applications.

Please answer the questions below to turn in at the end of class for participation/attendance credit.

Questions

1. **Scenario:** In many applications, the relationship between physical quantities is nonlinear. One such example is the drag force experienced by an object moving through air. Suppose you are given the following graph:



   Your task is to predict drag force when the velocity reaches 40 m/s. Without any calculus, can you come up with a simple prediction? Eyeball estimates are fine!

2. Now let's consider using AI to assist us in this activity. Please select an AI system (e.g., ChatGPT, Gemini, or Claude) and tell us what system you selected here:

3. Ask the AI system if it can interpret a graph if you give it an image. Can it?

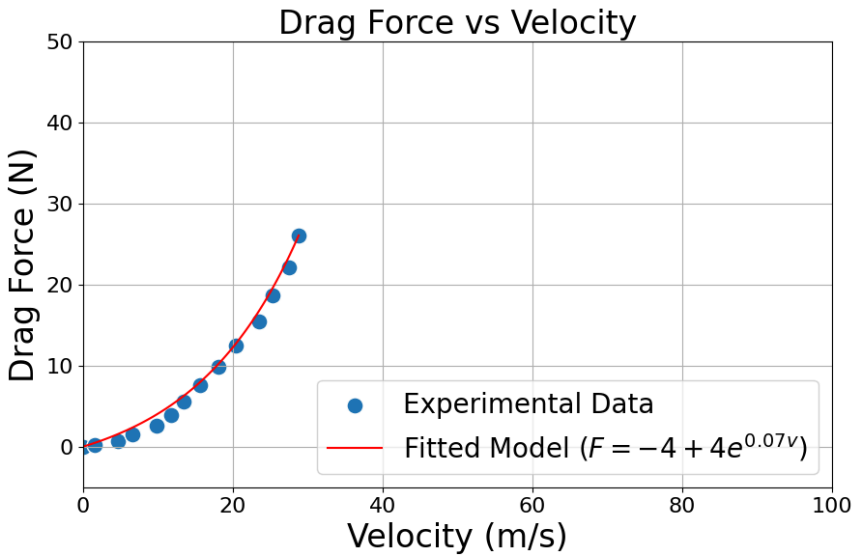
4. If the answer was yes, upload this file (link here) into the system. Otherwise, provide your AI system with estimates of 3 data points from the graph you have (e.g. 3 points like (29,26)).
5. Ask your AI system to make a linear fit to the data in the graph or the points you've provided. Write down the equation it produces below:

6. Use the equation above to compute the drag force when when v = 40 m/s:

7. Now let's put AI aside and use *linear approximation* (i.e. a tangent line) to approximate the drag force when v = 40 m/s ourselves, using a model fit to the data, given by the function:

   $F(v) = -4 + 4e^{0.07v}$

   We show a graph of this model fit below.



Using this model function F(v), linear approximate the drag force when v = 40 m/s using a tangent line.

Reflection

1. Do the AI linear fit and your linear fit match? Do your approximations at v = 40 m/s match? Briefly explain.

2. Did your AI system use derivatives in its approximation? If you are unsure, ask your AI system whether it did, and provide its answer below.
3. **Individual Reflection:** please fill out the worksheet activity survey before you leave class today.
4. **Turn in this worksheet.**

Both your survey response and turning in this worksheet will count for participation for today.

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2.2.7: Linear Approximation in Google Search Metrics

Objective

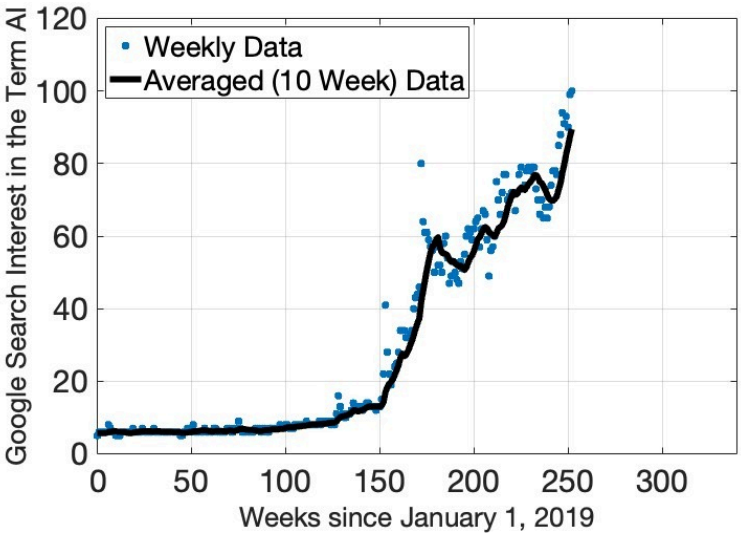
To understand the concept and application of linear approximation through exploration, group collaboration, and real-world applications.

Directions

Please answer the questions below to turn in at the end of class for participation/attendance credit.

Questions

1. **Scenario:** suppose you are given the following graph:



Your task is to predict interest in AI by week 260. What information do you need to do this?

2. Given the information you have already, can you come up with a prediction? Estimates are fine!

3. Now let's consider using AI to assist us in this activity. Please select an AI tool (e.g., ChatGPT, Gemini, or Claude) and tell us what tool you selected here:

4. Ask the AI tool if it can interpret a graph if you give it an image. Can it?

5. If the answer was yes, upload this file (link here) into the tool. Otherwise, provide your AI tool with estimates of 3 data points from the graph you have (e.g. 3 points like (200,60)).

6. Ask your AI tool to make a linear fit to the data in the graph or the points you've provided. Write down the equation it produces below:

7. Does the linear fit equation the AI tool developed seem appropriate? Why or why not? (For example, is it a line? Do the numbers involved look reasonable? Are there numbers involved?)

8. Now ask the AI tool to use calculus *without trigonometry* to create a model for AI interest over time. Write the model it

produces below:

9. Now as the AI tool to use the model it produced to *linearly approximate* AI interest in Week 260. Write down the approximation below:

Reflection

1. Does the AI prediction for AI interest in Week 260 seem appropriate, according to our graph? Explain.
2. Did your AI tool use derivatives in this approximation? If you are unsure, ask your AI tool whether it did, and provide its answer below.
3. Ask the AI tool to graph the model, the linear approximation for AI interest, and the original data on the same graph. Then answer one of the following (whichever is appropriate)
    1. If the tool is able to create a graph, does the graph seem reasonable? (Does it fit the original data?)
    2. If the tool is unable to graph, how else could you try to understand this problem?
4. **Individual Reflection:** please fill out the worksheet activity survey before you leave class today.
5. **Turn in this worksheet.**

Both your survey response and turning in this worksheet will count for participation for today.

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2.2.8: Understanding Graphs and Derivatives

To explore the connection between graphs and derivatives and the graphical capabilities of genAI.

Each group will submit a completed worksheet at the end of class. Include the names of all group members and clearly explain your work below.

Warm-Up Question

1. Sketch a graph of f(x) = x3+5x2-6x, and its derivative.

AI Exploration

2. **AI system:** select an AI system that you want to try to use today for this activity (Claude.ai, chatGPT, Gemini, etc.). AI system selected:
3. Ask the AI system to explain what the graphs of f(x) and its derivative should look like and what their graphical relationship is. **Please summarize its response below.**

4. Now ask your system if it can show you a graph depicting this relationship.
    1. Is the AI system able to graph f(x) and its derivative?
    2. If so, does the graph look like the one you drew in #1?

5. Ask your AI system if it can explain how a second derivative is related to the original function. If it uses terminology you haven't heard of, ask it to define the terms. **Briefly summarize its response below.**

6. Ask again if your AI system can generate a graph depicting this. **Sketch the graph below, if possible. If not possible, explain what happened.**

Reflection

1. **Individual Reflection:** please fill out the worksheet activity survey before you leave class today.
2. **Turn in this worksheet.**

Both your survey response and turning in this worksheet will count for participation for today.

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2.2.9: Application- Elasticity and Practice Tests

To explore the concept of elasticity, a real-world calculus application in economics, as well as how to generate and evaluate practice problems for studying.

Each group will submit a completed worksheet at the end of class. Include the names of all group members and clearly explain your work below.

1. **AI system:** as a group, select an AI system that you want to try to use today for this activity. Write your AI system selection here:
2. **Generating Questions:** Ask your AI system to generate a list of 2 questions related to elasticity using calculus. Remind the system that you are in a calculus 1 course focused on economics, where no trigonometry is required, you want it to use a variety of function types, and not to provide you answers to the questions. Write the 2 questions below:
    1.
    2.

3. **Critical evaluation:** answer the following questions.
    1. Do these questions look like what we have learned in class?
    2. If the questions do not look like what you have seen in class, try to provide it with an example of a question type and ask it to rewrite the questions.
    3. Do the questions cover a variety of function types or scenarios?
    4. If the questions do not cover a variety of function types or scenarios, ask it to rewrite the questions to cover a variety of function types or scenarios.

4. **Practice!** As a group, imagine this is a group quiz scenario where you have 10 minutes to complete these questions, 5 minutes per question. Write your answers below:
    1.

Reflection

1. **Individual Reflection:** please fill out the worksheet activity survey before you leave class today.
2. **Turn in this worksheet.**

Both your survey response and turning in this worksheet will count for participation for today.

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2.2.10: AI-Assisted Optimization

Use Generative AI to identify, generate, and diagnose common pitfalls in modeling and solving optimization word problems.

Each group will submit a completed worksheet at the end of class. Include the names of all group members and clearly explain your work below.

Part 1: Generating Modeling Errors

Optimization problems fail if the model is wrong. Ask your AI to generate common errors specifically related to setting up the problem.

Your Prompt to the AI

Generate 3 common conceptual errors students make when setting up Applied Optimization word problems in Calculus (focus on the objective function vs. constraint equations). For each error, give a description and a specific math example.

Record your results below:

Error Type 1
Description:

Example (Math/Equations):

Error Type 2
Description:

Example (Math/Equations):

Error Type 3
Description:

Example (Math/Equations):

Part 2: Challenge the Machine (Verification)

AI often struggles with the "First Derivative Test" vs. "Second Derivative Test" logic when justifying an answer.

Your Prompt to the AI

Solve the problem: Find two positive numbers whose product is 100 and whose sum is a minimum. Provide a solution that finds the critical point but fails to justify why it is a minimum.

1. What was the critical point found?
2. Let's investigate the "failure to justify why it is a minimum." Use the Second Derivative Test to prove this is a minimum.

Reflection

1. **Individual Reflection:** please fill out the worksheet activity survey before you leave class today.

2. **Turn in this worksheet.**

Both your survey response and turning in this worksheet will count for participation for today.

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2.2.11: Final Review Worksheet

To review topics from the entire course through group collaboration and real-world applications in economics, evaluate this activity co-designed by genAI and a real human, as well as what else you might need to study.

Each group will submit a completed worksheet at the end of class. Include the names of all group members and clearly explain your work below.

The Great Economic Optimization Heist

Created with love by Professor Julie Simons and ChatGPT 4o (model as of 3/11/2025).

Mission Briefing: The Ultimate Heist

🚨 **Welcome to EconoCorp, a billion-dollar company about to launch the hottest new product: Gen Z Juice™.** This mystery drink supposedly boosts focus, helps you ace finals, and guarantees perfect "rizz" in social settings. But before it hits the market, the company needs YOU—a team of economic masterminds—to determine the best price and quantity to maximize profit.

🔎 **Mission Objective:**

- Find the **price** and **quantity** that will maximize **profit** and **revenue**.

- Determine the **profit-maximizing point** by analyzing **cost functions**.

- Use **elasticity** to decide whether to raise or lower prices.

🎬 ACT I: THE SETUP — Preparing for the Heist

🧰 **Tools You'll Need**

1. **q = _____ (What should this represent?)**
2. **p = _____ (What should this represent?)**
3. **Revenue Function:** Do we have an equation for this or might this be given to us?
4. **Cost Function:** Do we have an equation for this or might this be given to us?
5. **Profit Function:** Do we have an equation for this or might this be given to us?
6. **Elasticity of Demand:** fill in the formula below

$\eta_{q/p}$ = _____

🎬 ACT II: INFILTRATION — Breaking Into the Revenue Vault

Suppose the price for Gen Z Juice™ is modeled by **$p(q) = 50 - 0.5q$.**

🔐 **Step 1:** Break Into the Revenue Vault

$R(q)$ = _____ ← Write equation here

Check in: What values can **q** take? _____

🧠 **Step 2:** Find the Marginal Revenue

MR(q) = R'(q) =

Check in: What does **marginal revenue** represent, conceptually?

Follow up: So if **q=1**, would revenue go up if we increase our quantity? **Yes / No**

Follow up: So if **q=100**, would revenue go up if we increase our quantity? **Yes / No**

🗝️ **Step 3:** Identify the Critical Value

Solve R'(q)=0 → q = _____ units

📉 **Step 4:** Confirm the Maximum

R''(q) = _____

Is R'' < 0 at the Critical Value? Yes / No

🎭 Dramatic Heist Moment:

- "Alright, we've cracked the safe! The max revenue is at q = _____, but wait... revenue isn't everything. We need to calculate costs, or we'll end up bankrupt like those failed start-ups from 2019."

🎬 ACT III: THE INNER CHAMBER — Disarming the Cost Traps

EconoCorp's cost function is **C(q) = 5q + 20.**

Reflect: when **q = 0**, what is **C(q)**? What would this value represent?

Reflect: as **q** increases, what does **C(q)** do? What calculus concept describes this?

💣 **Step 1:** Build Your Profit Function

P(q) = R(q) - C(q) = _____

🧮 **Step 2:** Locate the Profit-Maximizing Critical Value

P'(q) = _____

Solve P'(q)=0 → q = _____ units

🔦 **Step 3:** Confirm Maximum Profit

P''(q) = _____

Is P'' < 0 at the Critical Value? Yes / No

🎭 Plot Twist:

- "Wait a second! Should we increase or decrease the price? Are we operating in an elastic or inelastic zone?"

🎬 ACT IV: THE INTELLIGENCE BRIEFING — Elasticity Recon

🕵️ **Step 1:** Re-write Elasticity Formula in terms of q only

$\eta_{q/p}$ = _____ ← No p's here, only q!

📊 **Step 2:** Evaluate Elasticity at Optimal Quantity

$\eta_{q/p}$ = _____

🪄 **Step 3:** Re-Write Elasticity Formula in terms of price only

$\eta_{q/p}$ = _____ ← Write your answer in terms of p only

🧭 **Step 4: Pricing Decision**

Consider the fact that your business wants a STEADY revenue, less susceptible to sensitivities in price. Based on your answer above:

- If $|\eta_{q/p}| > 1$, demand is **elastic**: **Lower / Raise** the price? Why?

- If $|\eta_{q/p}| < 1$, demand is **inelastic**: **Lower / Raise** the price? Why?

🎬 ACT V: THE ESCAPE — Final Reflection

- "We did it! We cracked the optimization and stole the biggest profit possible from the economy." 💰🚀

- But wait... will Gen Z Juice™ be a success or a flop?

🎤 Team Reflection:

- How did calculus help us make a **real-world** economic decision?

Answer

- What happens if we **ignore marginal costs** or **miscalculate elasticity**?

Answer:

- Reflection:

Did this review activity cover all concepts from this course? **Yes / No**

Did this review activity cover all function types from this course? **Yes / No**

What else do you plan to do to review for the final exam?

🚀 Closing Thought:

"Optimization isn't just math—it's **how companies make millions**. And now, you know the secret formula." 🎬 **END SCENE.**

Last steps:

1. **Individual reflection:** Please fill out the final survey about your experience in this class.
2. **Turn in this worksheet.**

Both your survey response and turning in this worksheet will count for participation for today.

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2.3: CALCULUS 2

In this section, we provide worksheets developed specifically for Calculus 2 courses, covering:

1. Definite and indefinite integrals
2. Partial fraction decomposition and rational function manipulation
3. Integration by parts
4. Work integrals

Also included is an activity on exponential and logistic growth models, which is not standard in most calculus 2 courses and requires some basic differential equations and the method of separation of variables.

2.3.1: Introduction to Partial Fraction Decomposition and Textbook

2.3.2: Definite Integrals

2.3.3: Exponential and Logistic Growth Models

2.3.4: Integration by Parts

2.3.5: Work Integrals

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2.3.1: Introduction to Partial Fraction Decomposition and Textbook

Objective

To explore how to use MathGPT in our class and review a few topics for this course.

Please form groups of around 3 for this activity. Each group will submit a completed worksheet at the end of class. Include the names of all group members above and clearly explain your answers below.

Warm Up Questions

1. **Check In:** Does your group remember what a rational function is? If so, define it below in basic terms.
2. Simplify the following: $\frac{x^3-x}{x}$
3. Simplify the following: $\frac{x^3-x}{x+1}$
4. Reduce the fraction $\frac{x^2-x}{x+1}$ as much as possible (i.e. divide the polynomials).

Using our Textbook

5. Now, navigate to our textbook section on Dividing Polynomials.
6. Find the problem labeled Example 1.
    1. Hover your cursor over the box for Example 1.
    2. Click on “Click to interact” and then “Ask a Question.” You will see the chat bot activate to the right of the page.
    3. The chat bot wants to help you understand this problem. Select one of the suggested questions or enter your own question into the chat box.
    4. Now, using the chat bot’s help (if needed) and Example 1, either check your work or attempt to solve problem 4 (on the last page): divide $\frac{x^2-x}{x+1}$.

A Deeper Problem

7. Suppose we have this expression: $\frac{2}{x^2-1}$. Factor the denominator to rewrite the expression.

8. Recall that we use common denominators to *combine* fractions. For example, $\frac{2}{3}+\frac{5}{4}=\frac{2\cdot4}{3\cdot4}+\frac{5\cdot3}{4\cdot3}=\frac{2\cdot4+5\cdot3}{3\cdot4}$. Fill in the question marks in the equation below to translate this common denominator process to the expressions you had above: $\frac{A}{?}+\frac{B}{?}=\frac{2}{?}=\frac{2}{x^2-1}$.

9. Now, you should have $\frac{A}{x+1}+\frac{B}{x-1}=\frac{2}{x^2-1}$. Try to solve this equation for A and B using whatever method you can devise.

Reflection

1. **Individual Reflection:** please fill out the worksheet activity survey before you leave class today.
2. **Turn in this worksheet.**

Both your survey response and turning in this worksheet will count for participation for today.

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2.3.2: Definite Integrals

Objective

To review basic properties of functions and integration and the meaning of definite integrals, and how to generate practice problems for studying.

Answer the questions below or fill in the blank. Each student will submit an individual completed worksheet at the end of class. We encourage you to work through this with a friend or two, though!

Warm Up Questions

1. Definition of Negative Exponents: $\frac{1}{x^n} =$ _____
2. Definition of Rational Exponents: $\sqrt[m]{x^n} =$ _____
3. Three basic properties of definite integral: fill theese in.
    1. $\int f(x) \pm g(x)dx =$ _____
    2. $\int af(x)dx =$ _____
    3. $\int x^n dx =$ _____
    4. $\int x^{-1} dx =$ _____
    5. $\int_a^b f(x)dx = -\int_?^? f(x)dx$. What should the question marks be?
4. Sketch a simple function (e.g. $f(x) = x^2$) and shade the area representing $\int_0^2 f(x)dx$ below.

Generating Practice Questions

2. **AI system:** select an AI system that you want to try to use today for this activity (e.g. gemini, claude, chatGPT). Write your AI system selection here:
3. **Generating Questions:** Ask the AI to generate practice problems with the prompt below.

    Your Prompt to the AI

    Create 2 definite integral problems (1 conceptual, 1 computational) *without providing answers and without trigonometry.*

    Write these problems below.
    1.
    2.
4. **Critical evaluation:** Do these questions satisfy what we asked for? YES/NO (circle one)

If not, re-prompt your AI system to do what you are looking for.

5. **Practice!** Complete 1 of the 2 questions (it's your choice which one to choose). Write your answer below (everyone should write their answer on their own worksheet):

Reflection

6. **Checking our work:** Ask your AI system for its answer to the problem. Does it match yours? How would you know which is correct?

7. **Individual Reflection:** please fill out the worksheet activity survey before you leave class today.
8. **Turn in this worksheet.**

Both your survey response and turning in this worksheet will count for participation for today.

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2.3.3: Exponential and Logistic Growth Models

Objective

Use Generative AI to explore exponential and logistic growth models.

Directions

Each group will submit a completed worksheet at the end of class. Include the names of all group members and clearly explain your work below.

Part 1: What are these models?

1. **AI system:** as a group, select an AI system (Claude, Gemini, chatGPT, etc.) to use today for this activity. Write your AI system selection here:

2. **Generating Questions:** Ask your AI system to generate an explanation of exponential and logistic growth using the prompt below.

   Your Prompt to the AI

   Summarize the exponential growth model and logistic growth model.

   From your AI output, write down the mathematical formulas and indicate all parameters and input or output variables below.

   1. Exponential Model:

   2. Logistic Model

Model Meaning

1. Ask your AI system to explain some key differences between the exponential growth model and logistic growth model. List one difference below.

2. In what real life case scenarios could we apply an exponential growth model?

Practice

4. Ask your AI system to generate problems using the prompt below.

Your Prompt to the AI

Generate 1 exponential growth model question and 1 logistic growth model question, but do not provide solutions. These should be solve-able using paper and pen, for a calculus 2 student.

Imagine this is a group quiz scenario where you have 10 minutes to complete these questions. Write the problems & a summary of your work below:

1. Exponential Question:
2. Logistic Question:

Reflection

5. **Group reflection:** Do the questions above look related to topics we have learned in class?
6. **Individual Reflection:** please fill out the worksheet activity survey before you leave class today.
7. **Turn in this worksheet.**

Both your survey response and turning in this worksheet will count for participation for today.

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2.3.4: Integration by Parts

Objective

Review basic derivative rules to find an answer to an integral that involves a product of functions and use genAI to explain how to find the solution and process.

Directions

Each student will submit an individual completed worksheet at the end of class. We encourage you to talk to your classmates as you work, though!

Warm Up Questions

Refresher of material from Calculus 1:

1. Find the derivative of $f(x) = x \ln x$.

2. What derivative rule did you use to find $\frac{d}{dx} f(x)$?

3. In general, if $f(x) = u(x)v(x)$ then what is $f'(x)$?

A Tricky Integral

Your task is to find the indefinite integral of $g(x) = xlnx$, ***using only what we've covered so far in this class.***

Caution

If you have learned integration by parts (IBP) in another course, do NOT use it here. Try to use only topics we have covered so far

Hint

Try $G(x) = f(x) + h(x)$ where $f(x)$ is the same as in question 1 above and $h(x)$ is an arbitrary function. Try to solve for what $h(x)$ needs to be to make $G'(x) = g(x)$.

GenAI Explanations

1. **AI system:** select an AI system that you want to try to use today for this activity (Claude.ai, chatGPT, Gemini, etc.). AI system selected:

2. Ask the AI system to give a step by step explanation of this tricky integral problem using the prompt below.

   Your Prompt to the AI

   Give a step by step explanation of how to find the indefinite integral of $g(x) = xlnx$.

   Did the AI system do anything different than you did? Write down any unfamiliar terms and ask the AI system to define them.

3. Ask the AI system to explain the connection between integration by parts and the product rule. Briefly **summarize** its response below. Reflect (internally or in writing) on how this connects to the way you solved the problem earlier.

Reflection

1. **Individual Reflection:** please fill out the worksheet activity survey before you leave class today.
2. **Turn in this worksheet.**

Both your survey response and turning in this worksheet will count for participation for today.

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2.3.5: Work Integrals

Use Generative AI to explore work problems and their associated integral set up.

Directions

Each group will submit a completed worksheet by the end of class. Include the names of all group members and clearly explain your work below.

Questions

1. **AI System:** select an AI tool that you want to try to use today for this activity (e.g. Gemini, Claude, chatGPT). Write your AI System selection here:

2. **Writing good prompts is a skill.** Let's practice using an LLM to create a practice problem by using the exact prompt given below

Your Prompt to the AI

I'm learning to set up work integrals in Calc 2. Create 1 practice problem either about pumping liquid from a tank or lifting a cable or chain. Make it realistic but with simple numbers, and DON'T include solutions. I want to try them myself first.

Write the problem here:

3. **Critical evaluation:** Do these questions satisfy what we asked for? YES/NO (circle one)

   If not, prompt your tool to rewrite the question.

Practice without AI

4. Follow these two steps WITHOUT using AI:

   1. Sketch your understanding of the problem and label your coordinate system:

   2. Set up your integral for work using your sketch and write your answer below. Things to consider:
      1. What does your variable represent?
      2. What are the limits of integration?
      3. What's inside the integral? (Why?)

Using genAI to Check our Thinking

5. Don't just ask for the answer, try this prompt (but edit the part in brackets to match what you did so far):

Your Prompt to the AI

I set up the integral as [type your integral as best you can]. Don't solve it for me, but guide me through checking: (1) Are my variables and coordinate system correct? (2) Are my integration limits right? (3) Did I set up the integrand correctly? Ask me questions to help me check my work.

6. Briefly summarize the AI feedback here:

7. Based on the feedback, what (if anything) would you change?

8. Incorporate any changes into your integral set up and write it here:
9. With your integral, list the method(s) you would use to attempt to solve the integral (but do not solve the integral). Methods include:, u-sub, undo-ing a power rule, etc.

9. Verify that these methods would be appropriate for solving this integral by asking the AI using the prompt below.

Your Prompt to the AI

I now have the integral of [insert your integrand here] from [insert lower bound here] to [insert upper bound here]. I think I would use [insert method(s) here] to solve this. Is this correct? Why?

10. Were you correct with these methods? YES/NO (circle one)
11. **Learning from Common Mistakes.** Type the prompt below into the AI.

Your Prompt to the AI

Create an example of a common INCORRECT integral setup a student might write for this problem. Just show the wrong setup - don't explain why it's wrong. I want to figure that out myself.

12. Identify what part(s) of the set up you believe is wrong and write this below.

13. Now check your work: ask the AI to explain what is wrong with the integral set up. Were you correct, according to the AI system? YES/NO (circle one)
14. Do you think the AI system's explanation is correct? YES/NO (circle one)

15. How else could you verify whether the integral set up is incorrect?

Reflection

1. **Individual Reflection:** please fill out the worksheet activity survey before you leave class today.

2. **Turn in this worksheet.**

Both your survey response and turning in this worksheet will count for participation for today.

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3: SURVEYS

In this section, we provide the surveys for each activity, but we have also created a repository for copying surveys as a Google Forms, in case this is helpful. Feel free to modify as needed for your activities. Please see 1.3: Why and How to Use Surveys for deployment details. Some of these survey questions were informed by *The No-Vibe Guide to LLMs* by Pedro Morales-Almazan (last accessed for this project on 9/15/2025).

3.1: College Algebra/Precalculus

3.1.1: General Problem Solving Survey

3.1.2: Utilizing Inverse Functions Survey

3.1.3: Linear vs. Exponential Functions Survey

3.2: Calculus 1

3.2.1: Introduction to Piecewise Functions and Textbook Survey

3.2.2: Definition of Derivative and Practice Tests Survey

3.2.3: Exploring Implicit Differentiation in Economics Survey

3.2.4: Chain Rule Exploration and Error Generation Survey

3.2.5: Application- Understanding Marginal Functions Survey

3.2.6: Linear Approximation in Velocity and Drag Force Survey

3.2.7: Linear Approximation in Google Search Metrics Survey

3.2.8: Understanding Graphs and Derivatives Survey

3.2.9: Application- Elasticity and Practice Tests Survey

3.2.10: AI-Assisted Optimization Survey

3.2.11: Final Review Worksheet Survey

3.3: Calculus 2

3.3.1: Introduction to Partial Fraction Decomposition and Textbook Survey

3.3.2: Definite Integrals Survey

3.3.3: Exponential and Logistic Growth Models Survey

3.3.4: Integration by Parts Survey

3.3.5: Work Integrals Survey

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3.1: COLLEGE ALGEBRA/PRECALCULUS

In this section, we provide surveys for each worksheet from Section 2.1:

- 3.1.1: General Problem Solving Survey
- 3.1.2: Utilizing Inverse Functions Survey
- 3.1.3: Linear vs. Exponential Functions Survey

3.1.1: General Problem Solving Survey

3.1.2: Utilizing Inverse Functions Survey

3.1.3: Linear vs. Exponential Functions Survey

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3.1.1: General Problem Solving Survey

After completing the activity 2.1.1: General Problem Solving, please answer the following questions.

1. What AI system did you use for this activity?
2. On a scale of 1 (not great) to 5 (great), how well do you think your AI tool did in checking your solution?
3. On a scale of 1 (very different) to 5 (very similar), how did your mathematical work to solve the problem compare to the AI tool's work?
4. Did your AI tool explain its reasoning in a way that made sense to you? YES/NO/I'm not sure (select one)
5. Did the LLM generate what you were expecting? YES/NO (select one)
    - If no, explain. (How was the output the chat bot generated different from what you expected?)
6. Did the output use incorrect terminology or approaches? (For example, did it generate responses that were not what you asked?)

    YES/NO/I'm not sure (select one)

    - If yes:
        1. Briefly describe the incorrect terminology or approach the AI system used below.
        2. Did the AI error(s) make understanding area problems more confusing? YES/NO (select one)
7. On a scale of 1 (low) to 5 (high), do you feel this activity helped improve your understanding of solving an application problem?
8. On a scale of 1 (low) to 5 (high), in general, how are you feeling about your learning in the course so far?

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3.1.2: Utilizing Inverse Functions Survey

After completing the activity 2.1.2: Utilizing Inverse Functions, please answer the following questions.

1. What AI system did you use for this activity?
2. On a scale of 1 (not great) to 5 (great), what did you think of the answer-checking capabilities of the AI system when you tried to verify your solutions?
3. On a scale of 1 (not great) to 5 (great), what did you think of the explanations of the AI system when you tried to verify your solutions?
4. Did the LLM generate what you were expecting? YES/NO (select one)
    - If no, explain. (How was the output different from what you expected?)
5. Did the output use incorrect terminology or approaches? (For example, did it generate responses that were not what you asked?)

    YES/NO/I'm not sure (select one)
    - If yes:
        1. Briefly describe the incorrect terminology or approach the AI system used below.
        2. Did the AI error(s) make understanding inverses more confusing? YES/NO (select one)
6. On a scale of 1 (low) to 5 (high), do you feel this activity helped improve your understanding of inverses?
7. On a scale of 1 (low) to 5 (high), in general, how are you feeling about your learning in the course so far?

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3.1.3: Linear vs. Exponential Functions Survey

After completing the activity 2.1.3: Linear vs. Exponential Functions, please answer the following questions.

1. What AI system did you use for this activity?
2. Was your AI tool able to plot the data you provided it? YES/NO (select one)
   - If yes, on a scale of 1 (not great) to 5 (great), was the AI tool able to graph effectively?
3. Did the equations it generated match the equations you came up with? YES/NO (select one)

   - If no, explain.

4. Did your AI tool explain its reasoning in a way that made sense to you? YES/NO/I'm not sure (select one)

   - If no, explain.

5. Did the LLM generate what you were expecting? YES/NO (select one)

   - If no, explain. (How was the output different from what you expected?)

6. Did the output use incorrect terminology or approaches? (For example, did it generate responses that were not what you asked?)

   YES/NO/I'm not sure (select one)

   - If yes:
     1. Briefly describe the incorrect terminology or approach the AI system used below.

     2. Did the AI error(s) make understanding linear and exponential functions more confusing? YES/NO (select one)
7. On a scale of 1 (low) to 5 (high), do you feel this activity helped improve your understanding of linear and exponential models?
8. On a scale of 1 (low) to 5 (high), in general, how are you feeling about your learning in the course so far?

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3.2: CALCULUS 1

In this section, we provide surveys for each worksheet from Section 2.2:

- 3.2.1: Introduction to Piecewise Functions and Textbook Survey
- 3.2.2: Definition of Derivative and Practice Tests Survey
- 3.2.3: Exploring Implicit Differentiation in Economics Survey
- 3.2.4: Chain Rule Exploration and Error Generation Survey
- 3.2.5: Application- Understanding Marginal Functions Survey
- 3.2.6: Linear Approximation in Velocity and Drag Force Survey
- 3.2.7: Linear Approximation in Google Search Metrics Survey
- 3.2.8: Understanding Graphs and Derivatives Survey
- 3.2.9: Application- Elasticity and Practice Tests Survey
- 3.2.10: AI-Assisted Optimization Survey
- 3.2.11: Final Review Worksheet Survey

3.2.1: Introduction to Piecewise Functions and Textbook Survey

3.2.2: Definition of Derivative and Practice Tests Survey

3.2.3: Exploring Implicit Differentiation in Economics Survey

3.2.4: Chain Rule Exploration and Error Generation Survey

3.2.5: Application- Understanding Marginal Functions Survey

3.2.6: Linear Approximation in Velocity and Drag Force Survey

3.2.7: Linear Approximation in Google Search Metrics Survey

3.2.8: Understanding Graphs and Derivatives Survey

3.2.9: Application- Elasticity and Practice Tests Survey

3.2.10: AI-Assisted Optimization Survey

3.2.11: Final Review Worksheet Survey

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3.2.1: Introduction to Piecewise Functions and Textbook Survey

After completing the activity 2.2.1: Introduction to Piecewise Functions and Textbook, please answer the following questions.

1. On a scale of 1 (low) to 5 (high), was the textbook chat bot useful for you in in working on the practice problem from the textbook?
2. Did the chat bot generate what you were expecting? YES/NO (select one)
    - If yes, explain. (How was the output the chat bot generated different from what you expected?)
3. Did the output use incorrect terminology or approaches? (For example, did it generate responses that were not what you asked or did not involve polynomial division?)

    YES/NO/I'm not sure (select one)

    - If yes:
        1. Briefly describe the incorrect terminology or approach the AI system used below.
        2. Did the AI error(s) make understanding integration by parts more confusing? YES/NO (select one)
4. On a scale of 1 (low) to 5 (high), do you feel this activity helped improve your understanding of piecewise functions?
5. If you have experience with other AI systems (such as ChatGPT, Claude, Gemini, etc.), did you notice any difference(s) between how the chat bot works and how other tools work? Explain.
6. On a scale of 1 (low) to 5 (high), in general, how are you feeling about your learning in the course so far?

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3.2.2: Definition of Derivative and Practice Tests Survey

After completing the activity 2.2.2: Definition of Derivative and Practice Tests, please answer the following questions.

1. What AI system did you use for this activity?
2. Did the LLM generate what you were expecting? YES/NO (select one)
    - If no, explain. (How was the output the chat bot generated different from what you expected?)
3. Did the AI error(s) make understanding the definition of derivative more confusing?

    YES/NO/I'm not sure (select one)
4. Did the output use incorrect terminology or approaches? (For example, did it generate responses that were not what you asked or did not involve the definition of derivative?)

    YES/NO/I'm not sure (select one)
    - If yes, briefly describe the incorrect terminology or approach the AI system used below.
5. On a scale of 1 (low) to 5 (high), how useful did you find the example problems?
6. On a scale of 1 (low) to 5 (high), do you feel this activity helped improve your understanding of the definition of derivative?
7. On a scale of 1 (low) to 5 (high), do you feel this activity helped improve your understanding of limits?
8. On a scale of 1 (low) to 5 (high), do you feel more confident in using AI tool(s) to help you understand mathematical concepts like limits and the definition of derivative?
9. Did you encounter any challenges in this activity? YES/NO (select one)
    - If yes, explain.
10. On a scale of 1 (low) to 5 (high), in general, how are you feeling about your learning in the course so far?

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3.2.3: Exploring Implicit Differentiation in Economics Survey

After completing the activity 3.2.3: Exploring Implicit Differentiation in Economics Survey, please answer the following questions.

1. What AI system did you use for this activity?
2. On a scale of 1 (not interesting) to 5 (very interesting), what did you think of the creative or alternative explanation the AI tool came up with?
3. Did the LLM generate what you were expecting? YES/NO (select one)
    - If no, explain. (How was the output the chat bot generated different from what you expected?)
4. Did the output use incorrect terminology or approaches? (For example, did it generate responses that were not what you asked?)

    YES/NO/I'm not sure (select one)
    - Briefly describe the incorrect terminology or approach the AI system used below.
5. Did the AI error(s) make the revenue part less useful?

    YES/NO/Other (select one)
    - If Other, please describe.
6. On a scale of 1 (low) to 5 (high), do you feel this activity helped improve your understanding of the implicit differentiation?
7. On a scale of 1 (low) to 5 (high), did the revenue example help solidify why we might use implicit differentiation in the real world?
8. On a scale of 1 (low) to 5 (high), in general, how are you feeling about your learning in the course so far?

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3.2.4: Chain Rule Exploration and Error Generation Survey

After completing the activity 2.2.4: Chain Rule Exploration and Error Generation, please answer the following questions.

1. What AI system did you use for this activity?
2. Did the LLM generate what you were expecting? YES/NO (select one)
    - If no, explain. (How was the output the chat bot generated different from what you expected?)
3. Did the output use incorrect terminology or approaches? (For example, did it generate responses that were not what you asked or did not involve the definition of derivative?)

    YES/NO/I'm not sure (select one)
    - If yes, briefly describe the incorrect terminology or approach the AI system used below.
4. On a scale of 1 (low) to 5 (high), do you feel this activity helped improve your understanding of the chain rule?
5. On a scale of 1 (low) to 5 (high), do you feel more confident in spotting errors in mathematical work involving the chain rule now?
6. On a scale of 1 (low) to 5 (high), in general, how are you feeling about your learning in the course so far?

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3.2.5: Application- Understanding Marginal Functions Survey

After completing the activity 2.2.5: Application- Understanding Marginal Functions, please answer the following questions.

1. What AI system did you use for this activity?
2. Did the LLM generate what you were expecting? YES/NO (select one)
    - If no, explain. (How was the output the chat bot generated different from what you expected?)
3. Did the output use incorrect terminology or approaches? (For example, did it generate responses that were not what you asked or did not involve the marginal functions or didn't reference econ?)

    YES/NO/I'm not sure (select one)
    - If yes, briefly describe the incorrect terminology or approach the AI system used below.
4. On a scale of 1 (low) to 5 (high), how useful did you find the AI-generated explanation?
5. On a scale of 1 (low) to 5 (high), do you feel this activity helped improve your understanding of marginal functions?
6. On a scale of 1 (low) to 5 (high), do you feel more confident in using AI tool(s) to help you understand applications of mathematics like marginal functions?
7. Did you encounter any challenges in this activity? YES/NO (select one)
    - If yes, explain.
8. On a scale of 1 (low) to 5 (high), in general, how are you feeling about your learning in the course so far?

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3.2.6: Linear Approximation in Velocity and Drag Force Survey

After completing the activity 2.2.6: Linear Approximation in Velocity and Drag Force, please answer the following questions.

1. What AI system did you use for this activity?
2. How well do you think your AI system did in predicting drag force from the data?
3. Did your AI tool seem to use calculus to inform its prediction?
4. Did the LLM generate what you were expecting? YES/NO (select one)
    - If no, explain. (How was the output the chat bot generated different from what you expected?)
5. Did the output use incorrect terminology or approaches? (For example, did it generate responses that were not what you asked or did not involve the definition of derivative?)

    YES/NO/I'm not sure (select one)
    - If yes, briefly describe the incorrect terminology or approach the AI system used below.
6. On a scale of 1 (low) to 5 (high), do you feel this activity helped improve your understanding of linear approximation?
7. On a scale of 1 (low) to 5 (high), did the application of drag forces and velocity help solidify why we might use linear approximation in the real world?
8. On a scale of 1 (low) to 5 (high), in general, how are you feeling about your learning in the course so far?

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3.2.7: Linear Approximation in Google Search Metrics Survey

After completing the activity 2.2.7: Linear Approximation in Google Search Metrics, please answer the following questions.

1. What AI system did you use for this activity?
2. On a scale of 1 (low) to 5 (high), how well do you think your AI system did in predicting drag force from the data?
3. Did your AI tool seem to use calculus to inform its prediction? YES/NO/I'm not sure (select one)
4. Did the LLM generate what you were expecting? YES/NO (select one)
    - If no, explain. (How was the output the chat bot generated different from what you expected?)

5. Did the output use incorrect terminology or approaches? (For example, did it generate responses that were not what you asked or did not involve the definition of derivative?)

    YES/NO/I'm not sure (select one)

    - If yes, briefly describe the incorrect terminology or approach the AI system used below.

6. On a scale of 1 (low) to 5 (high), do you feel this activity helped improve your understanding of linear approximation?
7. On a scale of 1 (low) to 5 (high), did the application of estimating GDP in the future help solidify why we might use linear approximation in the real world??
8. On a scale of 1 (low) to 5 (high), in general, how are you feeling about your learning in the course so far?

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3.2.8: Understanding Graphs and Derivatives Survey

After completing the activity 2.2.8: Understanding Graphs and Derivatives, please answer the following questions.

1. What AI system did you use for this activity?
2. On a scale of 1 (not great) to 5 (great), what did you think of the explanations about graphs that the AI system came up with?
3. Was your AI system able to show graphs? YES/NO (select one)
   - If yes, on a scale of 1 (not great) to 5 (great), was the AI tool able to graph effectively?
4. Did the LLM generate what you were expecting? YES/NO (select one)

   - If no, explain. (How was the output different from what you expected?)

5. Did the output use incorrect terminology or approaches? (For example, did it generate responses that were not what you asked?)

   YES/NO/I'm not sure (select one)

   - If yes:
     1. Briefly describe the incorrect terminology or approach the AI system used below.

     2. Did the AI error(s) make understanding graphs and derivatives more confusing? YES/NO (select one)
6. On a scale of 1 (low) to 5 (high), do you feel this activity helped improve your understanding of the graphical relationships between functions and their derivatives?
7. On a scale of 1 (low) to 5 (high), in general, how are you feeling about your learning in the course so far?

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3.2.9: Application- Elasticity and Practice Tests Survey

After completing the activity 2.2.9: Application- Elasticity and Practice Tests, please answer the following questions.

1. What AI system did you use for this activity?
2. Did the LLM generate what you were expecting? YES/NO (select one)
    - If no, explain. (How was the output the chat bot generated different from what you expected?)
3. Did the output use incorrect terminology or approaches? (For example, did it generate responses that were not what you asked?)
    - If yes:
        1. Briefly describe the incorrect terminology or approach the AI system used below.
        2. Did the AI error(s) make understanding elasticity more confusing? YES/NO (select one)
4. On a scale of 1 (low) to 5 (high), how useful did you find the AI-generated practice test questions?
5. On a scale of 1 (low) to 5 (high), do you feel this activity helped improve your understanding of elasticity?
6. On a scale of 1 (low) to 5 (high), do you feel more confident in using AI tool(s) to generate practice problems to study for a math class like AM 11A?
7. Did you encounter any challenges in this activity? YES/NO (select one)
    - If yes, explain.
8. On a scale of 1 (low) to 5 (high), in general, how are you feeling about your learning in the course so far?

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3.2.10: AI-Assisted Optimization Survey

After completing the activity 2.2.10: AI-Assisted Optimization, please answer the following questions.

1. What AI system did you use for this activity?
2. When you asked the LLM to generate common errors, did you spot any errors that you might have made in the examples?On a scale of 1 (not great) to 5 (great), what did you think of the explanations about graphs that the AI tool came up with? YES/NO (select one)
3. Did the LLM generate what you were expecting? YES/NO (select one)
    - If no, explain. (How was the output the chat bot generated different from what you expected?)
4. Did the output use incorrect terminology or approaches? (For example, did it generate responses that were not what you asked?)

    YES/NO/I'm not sure (select one)
    - If yes, briefly describe the incorrect terminology or approach the AI system used below.
5. In the last part, you were asked to us the Second Derivative Test to prove the critical point is a minimum (which the LLM failed to justify). Did this process help you understand how the LLM failed to justify the critical point was a minimum? YES/NO (select one)
6. On a scale of 1 (low) to 5 (high), do you feel this activity helped improve your understanding of optimization?
7. On a scale of 1 (low) to 5 (high), do you feel more confident in spotting errors in mathematical work involving optimization now?
8. On a scale of 1 (low) to 5 (high), in general, how are you feeling about your learning in the course so far?

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3.2.11: Final Review Worksheet Survey

After completing the activity 2.2.11: Final Review Worksheet, please answer the following questions.

Belongingness and Learning Environment

On a scale of 1 (strongly disagree) to 5 (strongly agree), indicate how much you agree with the following statements:

	1	2	3	4	5
I feel accepted in this course.					
I feel respected in this course.					
I feel valued in this course.					
I enjoy being an active participant in this course.					
I feel like I belong in math courses like this course.					
I feel like I belong in math courses in general.					

Mindset

On a scale of 1 (strongly disagree) to 5 (strongly agree), indicate how much you agree with the following statements:

	1	2	3	4	5
I am confident I have the ability to learn the material in this course, given enough time.					
I am confident I have the ability to explore mathematical work and highlight errors.					
I am confident I have the ability to suggest approaches for how to start solving a problem in this course.					
I am confident I have the ability to suggest approaches for determining whether an answer is correct or not.					

Perception of Learning

On a scale of 1 (strongly disagree) to 5 (strongly agree), indicate how much you agree with the following statements:

	1	2	3	4	5
I can apply calculus, including differentiation and limit evaluation, to solve problems in business and economics.					
I can derive and interpret derivatives of various functions, including logarithmic and exponential forms.					
I can solve optimization problems relevant to business and economic applications.					
I can approximate functions using linear and quadratic models.					
I can utilize differential calculus to explain key economic concepts.					

genAI Familiarity

On a scale of 1 (strongly disagree) to 5 (strongly agree), indicate how much you agree with the following statements:

	1	2	3	4	5

I was familiar with genAI before taking this course.					
I feel MORE familiar with genAI after taking this course.					

Perceptions of genAI

On a scale of 1 (strongly disagree) to 5 (strongly agree), indicate how much you agree with the following statements:

	1	2	3	4	5
I can evaluate the output of genAI tools to determine whether it makes sense mathematically, or not.					
GenAI can be a useful tool in learning.					
The textbook AI features were useful tools for this class.					
I liked the genAI activities.					
I am concerned about the use of genAI in education.					
I am concerned about the use of genAI and ethical scenarios (e.g. plagiarism or broader contexts like its use in hiring practices, etc.).					
I am concerned about the use of GenAI and environmental impacts.					

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3.3: CALCULUS 2

In this section, we provide surveys for each worksheet from Section 2.3:

- 3.3.1: Introduction to Partial Fraction Decomposition and Textbook Survey
- 3.3.2: Definite Integrals Survey
- 3.3.3: Exponential and Logistic Growth Models Survey
- 3.3.4: Integration by Parts Survey
- 3.3.5: Work Integrals Survey

3.3.1: Introduction to Partial Fraction Decomposition and Textbook Survey

3.3.2: Definite Integrals Survey

3.3.3: Exponential and Logistic Growth Models Survey

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3.3.1: Introduction to Partial Fraction Decomposition and Textbook Survey

After completing the activity 2.3.1: Introduction to Partial Fraction Decomposition and Textbook, please answer the following questions.

1. On a scale of 1 (low) to 5 (high), was the textbook chat bot useful for you in solving the polynomial division problems?
2. Did the chat bot generate what you were expecting? YES/NO (select one)
    - If no, explain. (How was the output the chat bot generated different from what you expected?)
3. Did the output use incorrect terminology or approaches? (For example, did it generate responses that were not what you asked or did not involve polynomial division?)

    YES/NO/I'm not sure (select one)
    - Briefly describe the incorrect terminology or approach the AI system used below.
4. On a scale of 1 (low) to 5 (high), do you feel this activity helped improve your understanding of polynomial division?
5. If you have experience with other AI systems (such as ChatGPT, Claude, Gemini, etc.), did you notice any difference(s) between how he chat bot works and how other tools work? Explain.
6. On a scale of 1 (low) to 5 (high), in general, how are you feeling about your learning in the course so far?

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3.3.2: Definite Integrals Survey

After completing the activity 2.3.2: Definite Integrals, please answer the following questions.

1. What AI system did you use for this activity?
2. Did the LLM generate what you were expecting? YES/NO (select one)
    - If no, explain. (How was the output the chat bot generated different from what you expected?)

3. Did the output use incorrect terminology or approaches? (For example, did it generate responses that were not what you asked?)

    YES/NO/I'm not sure (select one)

    - If yes:
        1. Briefly describe the incorrect terminology or approach the AI system used below.

        2. Did the AI error(s) make understanding definite integrals more confusing? YES/NO (select one)

4. On a scale of 1 (low) to 5 (high), did the question(s) generated by the AI system seem helpful for studying definite integrals?
5. On a scale of 1 (low) to 5 (high), did the AI system's answer to the problem help you understand the problem better?
6. On a scale of 1 (low) to 5 (high), do you feel this activity helped improve your understanding of definite integrals?
7. On a scale of 1 (low) to 5 (high), in general, how are you feeling about your learning in the course so far?

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3.3.3: Exponential and Logistic Growth Models Survey

After completing the activity 2.3.3: Exponential and Logistic Growth Models, please answer the following questions.

1. What AI system did you use for this activity?
2. Did the LLM generate what you were expecting? YES/NO (select one)
    - If no, explain. (How was the output the chat bot generated different from what you expected?)

3. Did the output use incorrect terminology or approaches? (For example, did it generate responses that were not what you asked?)

    YES/NO/I'm not sure (select one)

    - If yes:
        1. Briefly describe the incorrect terminology or approach the AI system used below.

        2. Did the AI error(s) make understanding exponential and logistic growth more confusing? YES/NO (select one)

4. On a scale of 1 (low) to 5 (high), how useful did you find the AI-generated practice test questions?
5. Did the AI-generated questions involve applications? YES/NO (select one)
6. Did the AI-generated questions involve differential equations? YES/NO/I'm not sure (select one)
7. Did the AI system solve the problems for you, or give you hints about the solution? YES/NO (select one)
8. On a scale of 1 (low) to 5 (high), do you feel this activity helped improve your understanding of exponential and logistic models and their applications?
9. On a scale of 1 (low) to 5 (high), do you feel more confident in using AI tool(s) to generate practice problems to study for a math class?
10. Did you encounter any challenges in this activity? YES/NO (select one)
    - If yes, explain.

11. On a scale of 1 (low) to 5 (high), in general, how are you feeling about your learning in the course so far?

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3.3.4: Integration by Parts Survey

After completing the activity 2.3.4: Integration by Parts, please answer the following questions.

1. What AI system did you use for this activity?
2. Did the LLM generate what you were expecting? YES/NO (select one)
    - If no, explain. (How was the output the chat bot generated different from what you expected?)

3. Did the output use incorrect terminology or approaches? (For example, did it generate responses that were not what you asked?)

    YES/NO/I'm not sure (select one)

    - If yes: briefly describe the incorrect terminology or approach the AI system used below.

4. Did the question(s) generated by the AI system seem helpful for studying integration by parts?

    YES/NO/I don't know (select one)

5. Did the AI system's answer to the problem help you understand the problem better? YES/NO (select one)
6. On a scale of 1 (low) to 5 (high), do you feel this activity helped improve your understanding of integration by parts?
7. On a scale of 1 (low) to 5 (high), in general, how are you feeling about your learning in the course so far?

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3.3.5: Work Integrals Survey

After completing the activity 2.3.5: Work Integrals, please answer the following questions.

1. What AI system did you use for this activity?
2. Did the LLM generate what you were expecting? YES/NO (select one)
    - If no, explain. (How was the output the chat bot generated different from what you expected?)

3. Did the output use incorrect terminology or approaches? (For example, did it generate responses that were not what you asked?)

    YES/NO/I'm not sure (select one)

    - If yes:
        1. Briefly describe the incorrect terminology or approach the AI system used below.

        2. Did the AI error(s) make understanding work integrals more confusing? YES/NO (select one)
4. On a scale of 1 (low) to 5 (high), was the AI feedback on your integral set up helpful?
5. On a scale of 1 (low) to 5 (high), do you feel this activity helped improve your understanding of work integrals?
6. On a scale of 1 (low) to 5 (high), did the example of an incorrect integral set up help you understand the problem better?
7. On a scale of 1 (low) to 5 (high), do you feel more confident in spotting errors in mathematical work involving the work integral set ups now?
8. On a scale of 1 (low) to 5 (high), do you think this activity was useful for learning about how I could prompt an LLM to help you learn?
9. On a scale of 1 (low) to 5 (high), in general, how are you feeling about your learning in the course so far?

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GLOSSARY

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Sample Word 1 | Sample Definition 1

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