



Current Formative Learning Methods

Text-heavy worksheets

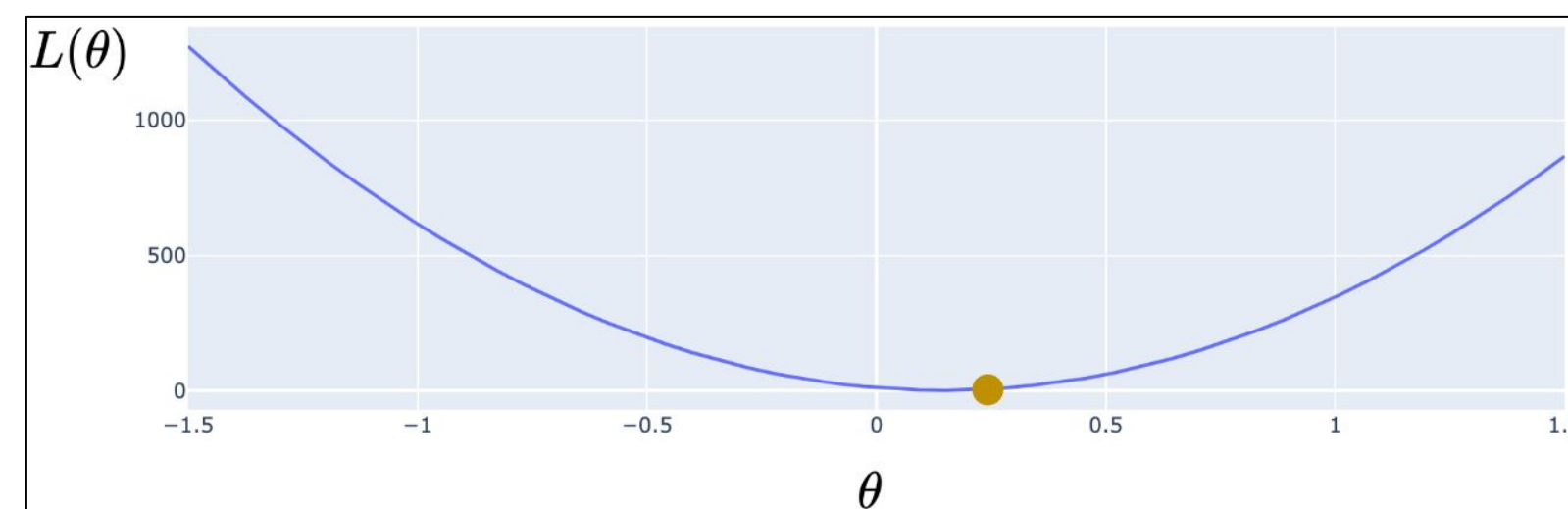
1. We want to minimize the loss function $L(\theta) = (\theta_1 - 1)^2 + |\theta_2 - 3|$. While you may notice that this function is not differentiable everywhere, we can still use gradient descent wherever the function *is* differentiable!

Recall that for a function $f(x) = k|x|$, $\frac{df}{dx} = k$ for all $x > 0$ and $\frac{df}{dx} = -k$ for all $x < 0$.

(a) What are the optimal values θ_1 and θ_2 to minimize $L(\theta)$? What is the gradient at those values $\nabla L = \begin{bmatrix} \frac{\partial L}{\partial \theta_1} & \frac{\partial L}{\partial \theta_2} \end{bmatrix}^T$ at $\theta_1 = \theta_1, \theta_2 = \theta_2$?

(b) Suppose we initialize our gradient descent algorithm randomly at $\theta_1 = 2$ and $\theta_2 = 5$. Calculate the gradient $\nabla L = \begin{bmatrix} \frac{\partial L}{\partial \theta_1} & \frac{\partial L}{\partial \theta_2} \end{bmatrix}^T$ at the specified θ_1 and θ_2 values.

Static visualizations

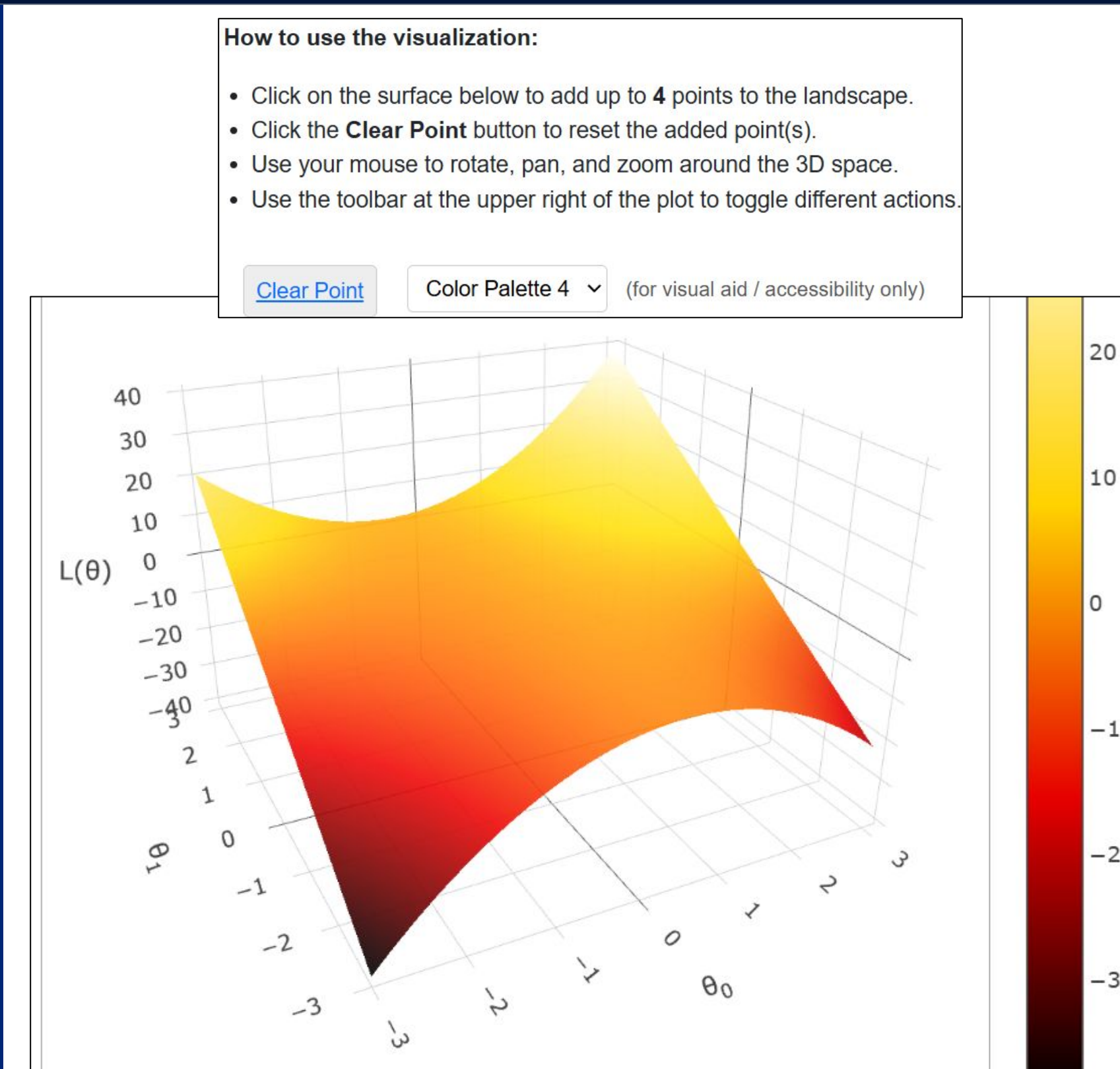


Our Work: A New Element

A 3D, interactive visualization tool inside PrairieLearn (an online assessment/learning platform) with dynamic rendering using Plotly

- Rotate, Zoom, Plot/Remove points on graphs
- Assess plotted points on the graph as answers to be marked
- Multiple colourways

PL-Interactive-Visualizer



Main Benefits

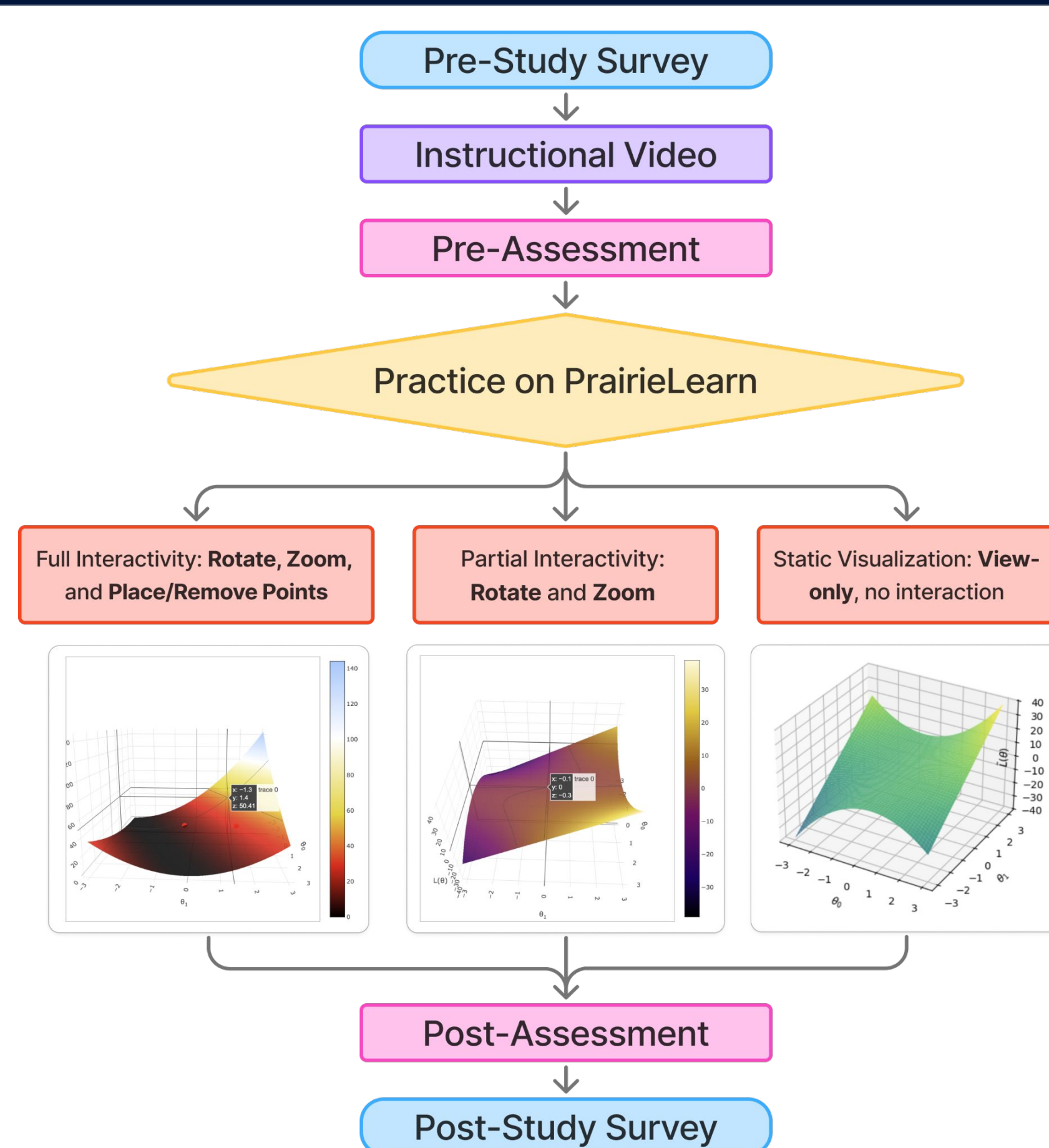
- Encourages **active learning** through direct manipulation with the visualization
- Stimulates interaction through **changing** and **responding**, which are more pedagogically engaging than just **viewing**
- **Applicable** across various courses and disciplines, such as identifying critical points and creating any surface visualizations

Research Question + Motivation

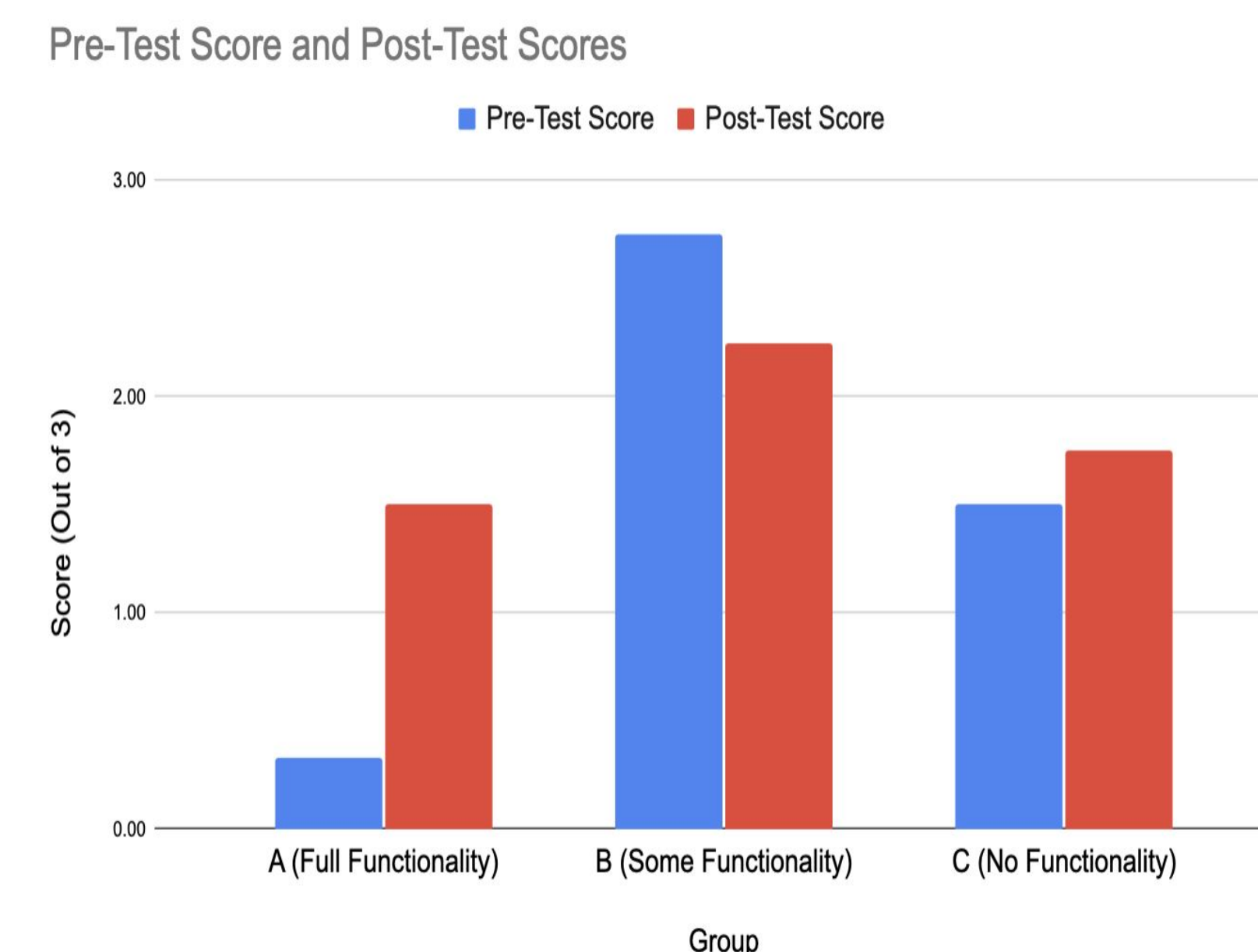
- RQ: Does **interactivity in visualizations** improve student's performance in formative assessments, as opposed to static visualizations?

Engagement Taxonomy:
Presenting > Constructing >
Changing > Responding >
Viewing > No Viewing

3-Group Study Format



Preliminary Results



- **N=7** (Group A: 3, Group B: 2, Group C: 2)
- Group A exhibited the most improvement between Pre and Post

User Feedback

- **Helpful** for **building intuition** when first learning about gradient descent
- The interactive visualization made it easy to **conceptualize** the landscape and optimal values
- Make it clearer to visualize or adjust the step size during gradient descent
- Allow for typing out coordinates to place points