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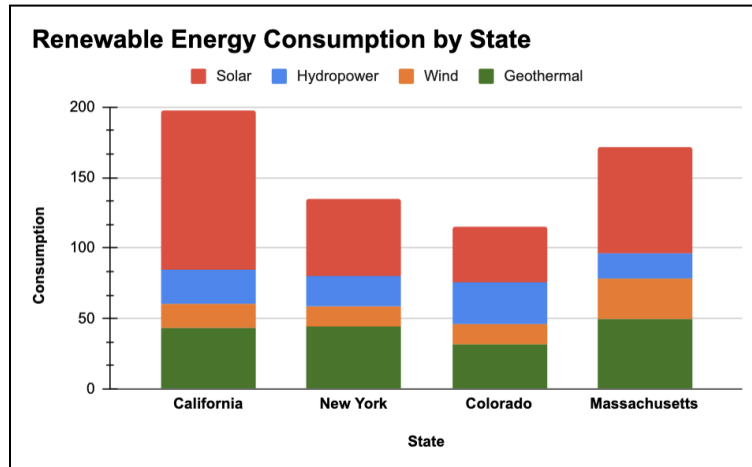
Module Four/Five: Experiments

Write-Up and Background Information

Preliminary Visualization

Our visualization problem addresses the presence of annotations in graphs, more specifically in stacked bar charts. Stacked bar charts are easy enough to read, but without specific labels for each bar, it may be difficult to comprehend the specific values that each bar represents. Labels on the graph could help to reduce cognitive load, enhance communication and accessibility, and improve data comprehension, but we wanted to see this idea in practice. We chose to do an experimental design set-up because we wanted to compare a test group to a control group when it comes to exploring the effect of annotations on data comprehension.

The target question for this experiment is "How does the presence of annotations affect comprehension in a data visualization?"

We will have 12 students to work with and they will be split up into two groups- Group A and Group B (we will adjust the groups accordingly based on how many students we have). We chose to use the energy data provided to us in Module 3, and used this data to create our visualizations. We will have four different graphs in this experiment. Graphs 1A and 1B will be the same graph based on Renewable Energy resource consumption, but 1A will have annotations and 1B will not. Graphs 2A and 2B will be the same graph based on Non-Renewable Energy resource consumption, but 2A will have annotations and 2B will not.

We plan to test the participants' comprehension with short quizzes. Groups A and B will receive the same comprehension quiz for Graphs 1A and 1B, respectively, but Group A will have seen the graph with annotations and Group B will have seen the same graph without the annotations. The same will be done for the quiz pertaining to Graphs 2A and 2B. In the end, Group A will

always see annotations, while Group B will never see annotations. We anticipate the quiz scores for Group A to be higher since they were exposed to annotations.

The quizzes will consist of five questions with a time limit of 1.5 minutes. We are including two sets of graphs to gain more data for our experiment.

The independent variable is whether there are annotations present in the visualization or not. The dependent variable is data comprehension. This will be measured through a short comprehension quiz that will be administered and the value will be the score (percentage of correctly answered questions) on that quiz. The control variables are the data content in the visualization, the layout of the visualization, the questions on the quiz, the amount of time to take the quiz, and the student. The only factor that is being manipulated is whether or not the student sees an annotation or not.

Our hypothesis states that if there are annotations on the graph, then participants will have a higher comprehension accuracy. We believe that we will see better scores when the annotations are present, given that the participants will only have a short period of time to take the quiz.

Some potential limitations of experimental design may include not accounting for participants prior experience with data visualizations. For example, students that regularly encounter graphs and have prior experience with analysis with graphs may do well on the quizzes, regardless of having annotations or not. Another limitation of our study may be some students may not have experience reading stacked bar charts specifically, so they may take most of the quiz time trying to figure out how to read the graph itself, instead of having the prior knowledge of how stacked bar charts work.

At the end of our experiment, we will have the participants fill out a feedback form to gain insight on what they thought about our design process, and if they personally felt like annotations had helped them or would have helped them comprehend our visualizations better.

Visualization with Annotations
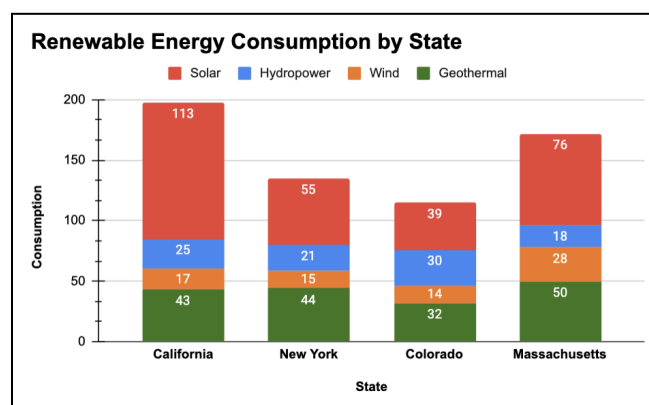
The table below explains our experiment more clearly.

Group A (Test)	Group B (Control)
Graph 1A (has annotations) → Renewable	Graph 1B (no annotations) → Renewable
Graph 2A (has annotations) → Non-Renewable	Graph 2B (no annotations) → Non-Renewable

Here are the links to our quizzes:
- [Quiz 1A](): Renewable energy graph with annotations (GROUP A)
- [Quiz 1B](): Renewable energy graph with NO annotations (GROUP B)
- [Quiz 2A](): Non-renewable energy graph with annotations (GROUP A)
- [Quiz 2B](): Non-renewable energy graph with NO annotations (GROUP B)
- [Feedback Form]()

Bells and Whistles
- *Live Deployment (2 pts)*
    - Snigdha: https://github.com/ssompall/module4-experiments.git
- *More Voices (3 pts)*
    - We reached out to three of our friends to partake in our experiment
    - Two girls were assigned to Group A
    - One girl was assigned to Group B

Analysis and Summary
Group A (9 people) → 7 in class, 2 recruited
Group B (7 people) → 6 in class (one was missing), 1 recruited

[Compiled Quiz Results Spreadsheet]()
[Feedback Form Results]()

Group A (Test)	Group B (Control)
Graph 1A (has annotations) → Renewable **Average Score: 84.4%**	Graph 1B (no annotations) → Renewable **Average Score: 60%**
Graph 2A (has annotations) → Non-Renewable **Average Score: 95.6%**	Graph 2B (no annotations) → Non-Renewable **Average Score: 88.6%**

The results of our experiment strongly supports our hypothesis that the presence of annotations has a positive impact on data comprehension in stacked bar charts. Participants in Group A, who were exposed to annotated visualizations, consistently performed better than those in Group B, who viewed the same graphs without annotations.

In the renewable energy category, Group A achieved an average score of 84.4%, whereas Group B, without annotations, scored lower with an average of 60%. Similarly, in the non-renewable energy category, Group A obtained an impressive average score of 95.6%, surpassing the average score of 88.6% achieved by Group B, which lacked annotations. On Quiz 2A, out of nine participants and a total of 45 answers (9*5), only two were incorrect.

The visual cues provided by annotations evidently reduce cognitive load, resulting in higher quiz scores, especially given the short time period to take the quiz. In addition, after looking at the feedback form results, everybody from Group A said that they thought that the annotations allowed them to do better on the quiz. Everybody in Group B said that having annotations would have allowed them to do better on the quiz.

However, there were some limitations of our study, such as not accounting for participants' varying levels of familiarity with data visualizations, and testing basic math skills at 8am in the morning. Future research would include giving out more quizzes at multiple different times of the day that are of different levels, to eliminate the bias as much as possible. Regarding this particular experiment, we had two quizzes of varying difficulty levels. Our quiz pertaining to Graphs 1A and 1B was much harder than the quiz relating to Graphs 2A and 2B. In the future, we would try to make the difficulty levels comparable and more controlled.

In conclusion, our experiment emphasizes the value of incorporating annotations as a best practice in designing effective visualizations, supported by the positive feedback from participants, as well as the difference in quiz scores. We would edit our preliminary visualization to reflect these changes.