

Design Report

Describe Data

My dataset “es_spend_2022.csv” utilizes data from multiple sources (linked by the state).

The United States Census Bureau provides information [on the public elementary-secondary education finances for fiscal year 2022](#), downloaded as “elsec22_sumtables.xls”. Specifically, the Per Pupil Current Spending (*ppcs* in my dataset) comes from Table 8, as the first column called “Total”. The per pupil revenue columns (*pp_rev_total*, *pp_rev_fed*, *pp_rev_state*, *pp_rev_local*) come from Table 11 under header “elementary-secondary revenue” with columns “Total”, “From federal sources”, “From state sources”, and “From local sources”, respectively.

The National Center for Education Statistics provides information on [mapping state proficiency standards of grades 4 and 8 in math and reading to the National Assessment of Educational Progress \(NAEP\) for 2022](#), downloaded as “table_2022a.xlsx” for Grade 4 Reading, “table_2022b.xlsx” for Grade 4 Math, “table_2022c.xlsx” for Grade 8 Reading, and “table_2022d.xlsx” for Grade 8 Math. For the NAEP columns (*g4_read*, *g4_math*, *g8_read*, and *g8_math*), the column used is the “NAEP equivalent” from their respective tables.

Additionally, the National Center for Education Statistics provides information on [SAT scores for seniors in 2022](#), downloaded as “tabn226.40.xlsx”. This provides information on the mean scores of the total SAT, the Evidence-based reading and writing (ERW) section, the Math section, and also the percent taking the SAT for each state.

Finally, the National Center for Education Statistics provides information [on ACT scores for seniors in 2022](#), downloaded as “tabn226.60.xlsx”. This provides information on the composite score of the ACT, the scores for the English, math, reading, and science sections, and the percent taking the ACT by state.

I chose this data to explore the relationship between academic finances and academic performance. Is there a correlation between current spending per pupil and academic performance? Is there a correlation between how a school raises funds and performance? How do states compare against each other both financially and academically? These questions can be investigated with the data and the chosen interactions.

Storyboards

Since the data focuses on states (+ District of Columbia), I want to utilize an interactive map. The map would be colored by a finance attribute. The user can hover over states to produce a

tooltip that displays the name of the state and the numeric value of the financial attribute. This allows the user to get more insight in the finances related to schools. If the user clicks on a state, then that state and corresponding attribute will appear in the bar charts to allow for easy comparison among different states at various financial and academic levels. Additionally, I want to have a scatter plot that shows a direct comparison between every state and the finance and performance attributes. This plot would also have tooltip functionality; by hovering over the point, the user can see which state it is and relevant performance attributes. This is essential since the user would otherwise not know what the points correlate to.

The user can also change the finance and performance attributes at any point on the website to explore the data at different levels. Choosing a finance attribute will change the color scale of the map (and the bar charts), the y-axis of the finance bar chart, and the x-axis of the scatter plot. Choosing a performance attribute will change the y-axis of the performance bar charts and the y-axis of the scatter plot, along with potentially changing the color scale of the scatter plot (some performance attributes share the same scale). The ability to change the attributes can allow the user to have a better picture on the relationship between finances and performance (and states).

The image below shows the final iteration of sketches before implementation. More of the sketch iteration process are shown later on in the report.

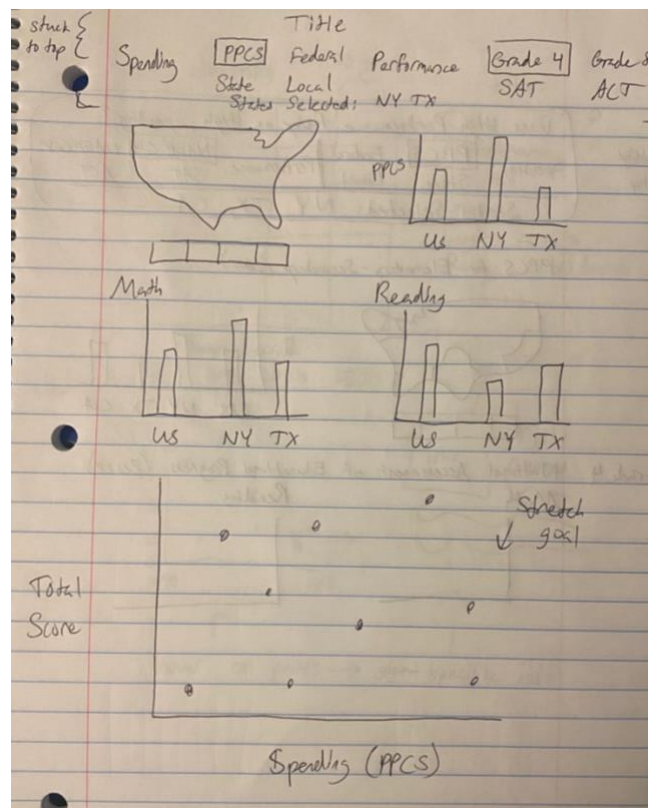


Figure 1. Final iteration of visualizations.

Final Visualization

My final interactive visualization application focuses on public elementary/secondary school finances and academic performance on national assessments. The user is able to select whichever finance attribute, whichever performance attribute, and whichever states they wish to compare with each other.

The map depicts the whichever financial attribute selected by using a quantile scale. Selected states will appear in all bar charts. The bar chart beside the map shows the financial attribute in comparison to the US (average). Changing the financial attribute will change the color scale and some axes.

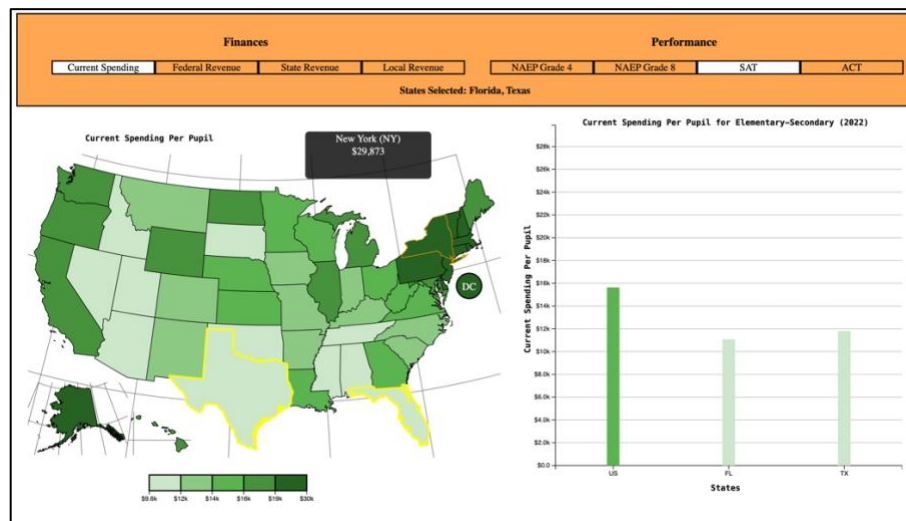


Figure 2. Map and bar chart depicting current spending per pupil.

The next set of bar charts showcase the performance attribute broken into math and reading sections. The colors are related to the financial attribute. If the state has no data present, an “N/A” will appear.

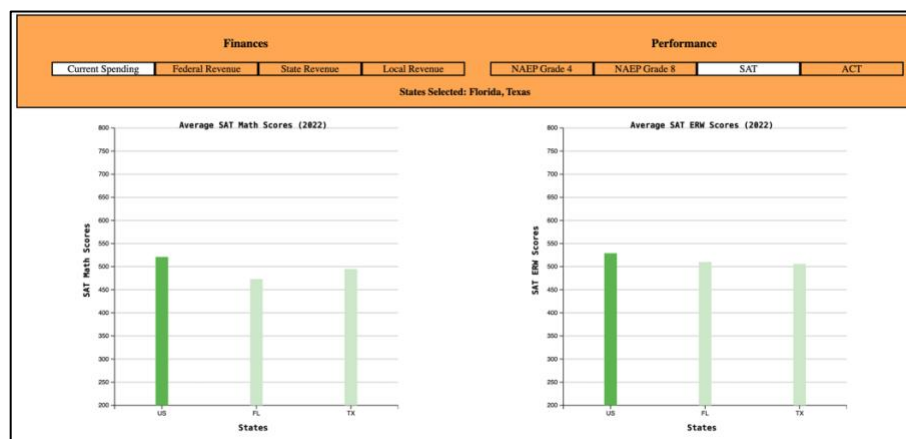


Figure 3. Bar charts showing performance on SAT sections.

The last visual is a scatter plot that changes based on which attributes are selected. If the performance attribute is either SAT or ACT, then the points will be colored by participation rate. Otherwise, the points are colored by subject and achievement level.

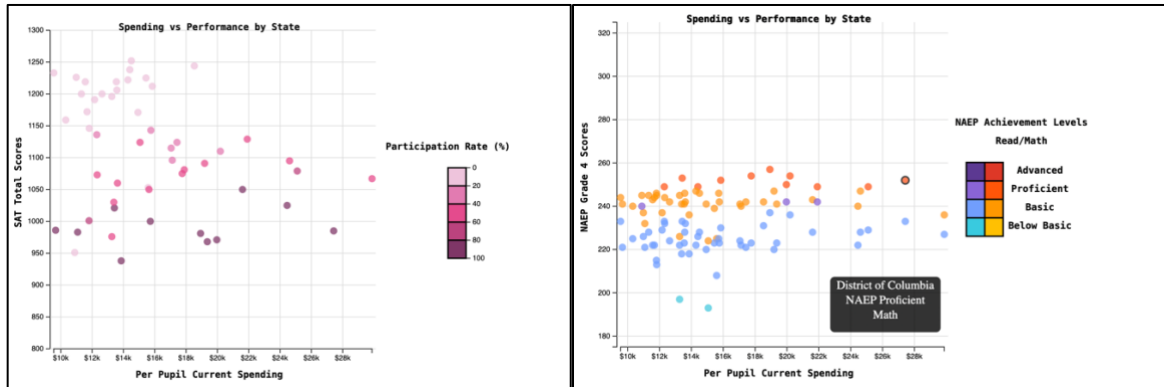


Figure 4. Scatter plots showing current spending per pupil by total SAT scores (left) and by NAEP Grade 4 assessment scores (right).

Trade-offs

Some people may not know they can select states from the map. To try to alleviate this, I added brief instructions in the beginning (before the visuals) and changing the style of the pointer. However, some people may skip over the instructions and not fully utilize the selecting states mechanism for the bar charts. Moreover, users may not realize there is a cap of the number of states to be selected (if they figure out how to select states without reading the instructions).

Additionally, having the financial and performance attributes at the top may mislead users; users may think the performance buttons are broken if they click them and see no changes when in the first set of visuals (map + finance bar chart). I tried to alleviate this by having headers for sections of visuals that imply which attributes are the focus like “Finances”.

Another potential issue is that users could get confused by the colors of the bar charts in the performance section if they change the finance attribute without seeing the scale. I believe the way I created the scales (with quantiles) will help the user better interpret when the color changes (since darker colors mean more money) but it still may be a pain area.

Development Process

During my first iteration, my focus was to explore the relationship between finance and performance at both the state and district level. This iteration features maps that hovering and clicking functionality similar to what I have implemented. Initially, I had plans to have a pan and zoom since the dataset included the District of Columbia and you could only select if you were on the exact, singular pixel. However, I decided against doing pan and zoom since people might

not even consider DC as a state, so it would essentially be pointless. Instead, I added a DC button on the map that makes DC noticeable as a selectable “state” (seen in Figure 6).

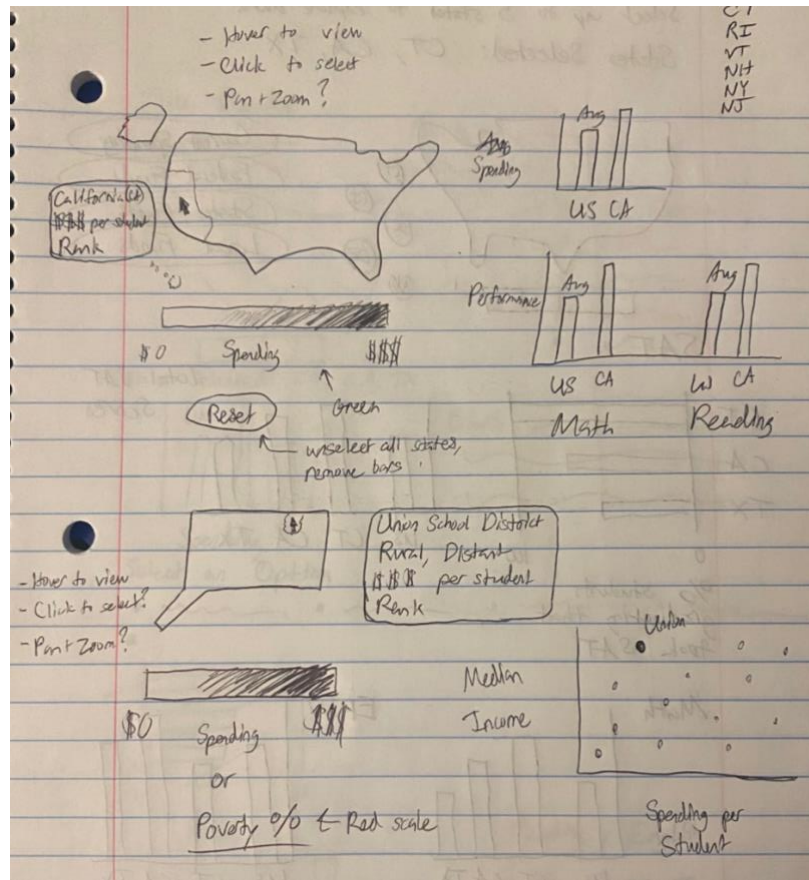


Figure 5. First iteration of visualizations.

During this iterative process, the interactivity was expanded to allow for the user to change the finance attribute (then later on to change the performance attribute) which allows them to further explore these relationships. The placement of these buttons was initially supposed to be beside the most relevant visualization. However, this could cause users to keep having to scroll back to these buttons if they wanted to view something differently. So, I decided to permanently keep them at the top of the page wherever they go, so there is less of an inconvenience.

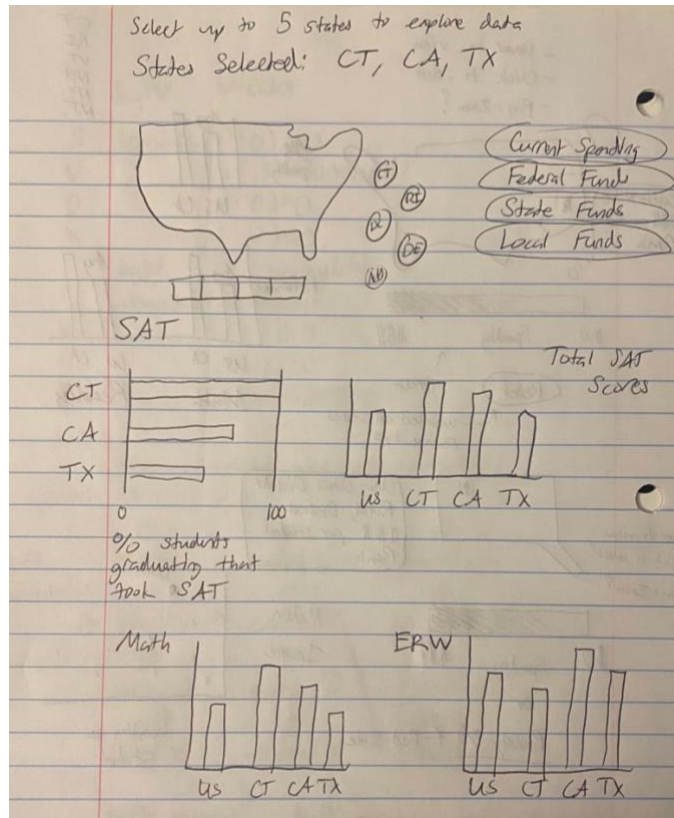


Figure 6. Intermediate iteration of visualizations.

A design choice I made was to visualize the user hovering/selecting a state on the map, in addition to just adding it to the selected states list. I decided to go with orange borders when hovering and a thick yellow border when the state is selected to contrast with the cool colors of the finance scales. I especially had difficulty changing the borders when implementing the DC button as there were some issues with it incorrectly showing that DC wasn't selected when changing the finance attribute. With changing the borders of the states, it makes it easier for the user to know what they have selected.

I decided to limit the number of states that can be selected at once. In the very first iteration of sketches, the user would have been able to select every state and then click reset to remove all the states. Having the user be able to look at a bar chart with 52 bars (all states + DC + US) would not be pretty to look at. During the first stages of implementation, I limited the number of states a user could select to 5 as it didn't clutter too much of the bar charts. However, I thought the users should be able to view more of the states, for example, if they wanted to compare the states in the same quantile. Thus, I changed the max number of selectable states to 11 so the user can select all states in a given quantile for comparison.

Contributions

- Curating the dataset (2 hours)
- Sketching/Storyboards (2 hours)

- Creating map visual (2 hours)
- Creating bar charts (2 hours)
- Selecting states interactivity (4 hours)
- Creating scatter plot (2 hours)
- Linking "Spending" options with all visuals (4 hours)
- Linking "Performance" options with bar charts (2 hours)
- Creating DC button for map (3 hours)
- Creating legends for map and scatter plot (3 hours)
- Formatting website (2 hours)
- Creating report (4 hours)