



JMP Instructional data set 004

Math and Reading Scores

JMP platforms and statistical methods

Graph Builder: Bar chart; line graph; geographic map
Formula Editor: Creating new variables
Bubble Plot: Dynamic scatter plot

Problem statement

Getting visibility into what students know and can do across a variety of subjects is extremely helpful in assessing the performance of the country's educational system. The National Center for Education Statistics (NCES) periodically conducts a national testing study known as the National Assessment of Educational Progress (NAEP) also referred to as "The Nation's Report Card" [1]. This nation-wide study provides the means to quantitatively assess student competency. These data are analyzed by researchers and others to identify trends and areas of concern, as well as compare performance between states, subjects, ages, gender, among other attributes. These insights help federal, state, and local school systems and policy makers develop paths to improve the country's schools.



The data that will be analyzed is from the mathematics and reading scores of 4th and 8th graders from 2003 to 2024. The focus of the analyses will be to create a variety of visualizations and use them to summarize test results, discover trends, make comparisons, and communicate features gleaned from the data.

Data

IDS_004.jmp

Year	Year of assessment (2003, , 2024)
Region	Groups of states defining 9 regions of the country
State	State name (including Washington D.C.)
Math 4th Grade	Average score of the mathematical assessment test of all 4th graders tested within each state each year
Reading 4th Grade	Average score of the reading assessment test of all 4th graders tested within each state each year
Math 8th Grade	Average score of the math assessment test of all 8th graders tested within each state each year
Reading 8th Grade	Average score of the reading assessment test of all 8th graders tested within each state each year

Exercises

The exercises will have you first create a variety of interactive visualizations. You'll then explore the data through these visualizations to find and describe features to produce insights into performance of the students in these grades and subjects across the country and over time.

1. Create a graph showing the scores for a chosen variable for all states across the years with a line going through the average

Instructions:

Graph > Graph Builder. Place 'Year' on the X axis, and 'Math 4th Grade' on the Y axis. Choose to display individual points and a connect line going through the average by selecting both those icons in the graph palette while holding down the shift key.  

Under the Red Triangle Menu, choose Redo > Column Switcher. Select 'Math 4th Grade' from the Initial Column list, and select that and the three other score variables for the Replacement Columns. The Column Switcher will appear on the left allowing you to select the variable to use.

2. Create a map of the United States where the color used for the states can be the values for any of the four scores variables in the data set for any year.

Instructions:

Graph > Graph Builder. Place 'State' in the center of the graph window. Place 'Math 4th Grade' in the Color Role. Then choose Redo > Column Switcher under the Red Triangle. Select 'Math 4th Grade' for the Initial Column to Switch. Then select that variable along with the other three score variables for the Replacement Columns.

The Column Switcher will appear on the left allowing you to select the variable to use. The colors are based on the average values across all the years. To display the values for a single year, set up a Local Data Filter. Select Local Data Filter under the Red Triangle. Select 'Year' as the filter variable. The Data Filter will now appear allowing you to select a specific year to use in the graph. Choose to use a quantile scale for the color by right clicking on the color scale and choose Gradient. Select Quantile as the Scale Type. Now the median (50th percentile) is grey, and the colors are based upon their percentile not actual values.

3. Create an overlay Time Series graph displaying the scores for each state across the years, with the ability to choose which variable to graph and which states to display.

Instructions:

Graph > Graph Builder. Place 'Year' on the X axis, and 'Math 4th Grade' on the Y axis. Choose the connect line icon in the graph palette. 

Place the 'State' variable in the Overlay Role.

Under the Red Triangle Menu, choose Redo > Column Switcher. Select 'Math 4th Grade' from the Initial Column list, and select that and the three other score variables for the Replacement Columns.

The Column Switcher will appear on the left allowing you to select the variable to use in the graph.

Add a Local Data Filter for 'Region', 'Division', and 'State'. Select Local Data Filter under the Red Triangle. Select those three variables and click the + symbol.

The Data Filter will now appear allowing you to select a specific set of states to use in the graph.

4. Create a new set of variables that is the difference in the scores for each state for a given year from the average of all states in that year.

Instructions:

Create a new column (Cols > New Columns). In the New Column dialog box, choose Formula in the Column Properties drop down menu. Select Edit Formula. In the Formula Editor, create the formula:

Math 4th Grade - Col Mean (Math 4th Grade, Year)

Note: The 'Col Mean' is in the Statistical category in the function list on the left. Name the new column 'Math_4th Grade_Diff from Yearly Avg'.

Repeat this for the other three variables.

5. Create a Bar Chart of the difference in the score for each state from the average score across all the states for each year, with the ability to display any of the difference scores for any year.

Instructions:

Graph > Graph Builder. Place 'State' on the X axis, and 'Math_4th Grade_Diff from Yearly Avg' on the Y axis. Choose Bar graph from the Graph Palette. 

Add a Local Data Filter for 'Year'. Select Local Data Filter under the Red Triangle. Select 'Year' as the filter variable. The Data Filter will now appear allowing you to select a specific year to use in the graph.

Under the Red Triangle Menu, choose Redo > Column Switcher. Select 'Math_4th Grade_Diff from Yearly Avg' from the Initial Column list, and select that and the three other new variables created for the Replacement Columns.

6. Create two Bubble Plots (one for each grade) that plots the Math vs Reading scores, with the ability to select which states to display.

Instructions:

Graph > Bubble Plot. Use 'Math 4th Grade' for the Y Role, and 'Reading 4th Grade' for the X. Use 'State' for the ID Role, 'Year' for Time, and 'State' for Coloring. Click OK.

In the graph, choose to turn off the legend by deselecting it in the Red Triangle menu. Select Trail Lines > All, and Labels > All under the Red Triangle menu.

Add a Local Data Filter for 'Region', 'Division', and 'State'. Select Local Data Filter under the Red Triangle. Select those three variables and click the + symbol. The Data Filter will now appear allowing you to select a specific set of states to use in the graph.

Click the play button to observe how the two scores change over time. 

7. Explore the data through the various interactive visualizations created. Create a brief report (e.g., 4-5 PowerPoint slides with brief bullet point sentences and graphs) describing some key findings.
Note: As there's many features in these data that can be reported on, select just a few themes to focus on that you would consider important and that can be communicated through these visualizations (e.g.,. Focus on some general trends observed nationally, or select states that have the most change in scores over time, choose to report on just one of the grades or subjects, or specific states, and/or years).
8. What are some other data that would be valuable to collect and analyze to help develop an even deeper understanding of the performance of our education system, possibly even finding potential causes for good/poor student performance?

Supporting materials

1. The National Assessment of Educational Progress (NAEP) "The Nation's Report Card" by National Center for Education Statistics (NCES).
<https://www.nationsreportcard.gov>

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