LET'S ARGUE: STUDENT WORK

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Contents

Student Movie Data Claims (Cycle 1)

Claim Evidence Reasoning

The average critic rating for original movies is typically higher than the average critic rating for sequels. Given that the average critic rating for a original film is 8.25, compared to a average sequel rating of 6.45 there is a 1.8 difference found in the average ratings. This supports the claim by showing that original films receive a higher critic rating whereas sequels, remakes, etc. receive a lower rating.

The average critic rating for original movies is typically higher than the average critic rating for sequels. The median rating for original films is 8.25 while the median for sequels is 6.45. This proves that the average critic rating for original movies is higher because the sequel data is very spread out while the original data is consistently higher on the plot

The average critic rating for original movies is typically higher than the average critic rating for sequels. This supports the claim because the average scores being higher for originals than sequels is basically saying strait up that the originals were rated better and its 8.25 to 6.45 so that's a massive difference on a 10 point scale.

This part needs to be explained more and should come before the reasoning statement(s).

The average critic rating for original movies is typically higher than the average critic rating for sequels. The evidence is that the median of the originals is 8.25/10 and the sequels average rating is 6.45. This means that the sub-claim that the average rating for originals is higher than sequels is true based on our data used.

The average critic rating for original movies is typically higher than the average critic rating for sequels. The median of original movie ratings is 8.25 and the median for sequel movie ratings is 6.45. That alone is not enough to prove that original movies are higher rated than sequels but the Q1 of original movies is also more than the Q3 of sequels. That shows that original movies are typically higher rated than the sequels because more than 75% of original movies are rated higher than 75% of sequels.

This last part is nice, but it does not provide evidence for comparing the medians

Original movies are typically better than sequels, the average critic rating for original movies is typically higher than the average rating for sequels. This is evidenced by the fact that the median critic score for original movies was 8.25, compared to a median of 6.45 for sequels.

This is a good beginning, but needs some reasoning (so, what?) to wrap up the paragraph.

Student Predictions About Car Data (Cycle 2)

Students were presented with the following information and asked to make predictions. Their responses are included below.

I have some data about cars, including

highway mpg (quantitative), curb weight (quantitative), and
fuel type (categorical: gas, hybrid, electric)

Think about how these variables might be related and make some predictions.

1. How might the highway mpg and curb weight be related?
    - The weight of the car the smaller the Mpg
    - The mpg will decrease with the curb weight
    - curb weight up mpg down
    - they could be related because of aerodynamics and how inertia would be taking the car
    - higher weight = less mpg; lower weight = more mpg
    - The higher the curb weight the lower the mpg
    - more weight may cause less mpg
    - more gas to make a heavier car go

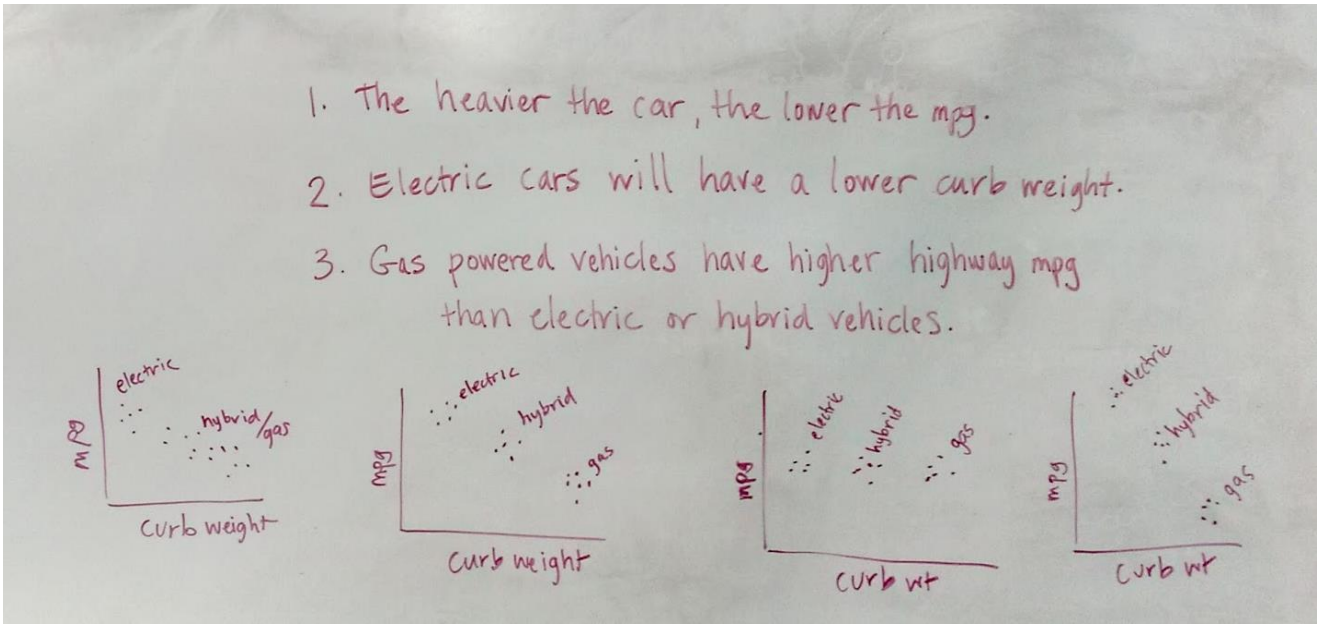
2. How might curb weight and fuel type be related?
    - Electricity weights less than gas
    - Heavier cars might use gas and lighter cars might use electricity or be hybrids
    - the curb weight would be lower if electric and hevier [sic] if hybrid
    - batteries weigh more than hollow gas tanks
    - gas/hybrid cars might be heavier on account of the engine
    - different fuel types have limited curb weight
    - weight might be lower for electric
    - higher curb weight will need more efficient fuel to go a long distance

3. How might highway mpg and fuel type be related?
    - Some fuel lasts longer than others
    - Cars that can use electricity might have higher mpg
    - more efficient feul [sic] better mpg
    - electric might be more efficient than gas/hybrid
    - different fuel types have better mpg
    - MPG may be higher for gas cars
    - Some fuel will mean more highway mpg than others

4. Do you think there might be outliers or influential points? If so, what might they be?
    - Yes different models of cars will put outliers for the categories
    - It is likely. There might be a car that is heavy but has a high mpg, or a light car that has a low mpg.
    - most likely no because most manufactuers [sic] would try to be similar and efficient
    - yes there would be at least one outlier: a hummer

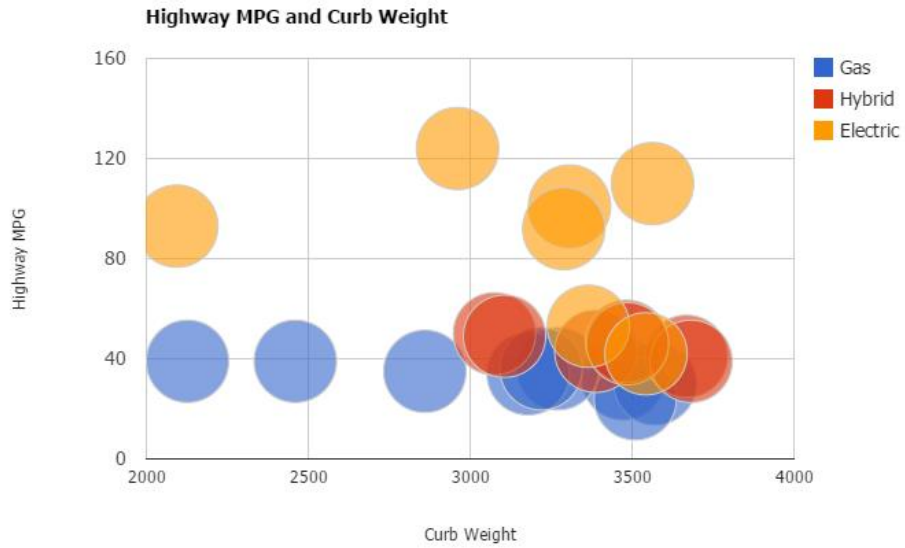
- some outliers might be much less/more efficient
- probably not
- maybe hummer or something that consumes a ton of fuel
- yes because of different cars, antiques are going to take more gas than new cars

After students wrote their predictions, we discussed each question as a class. The picture below summarizes the discussion.

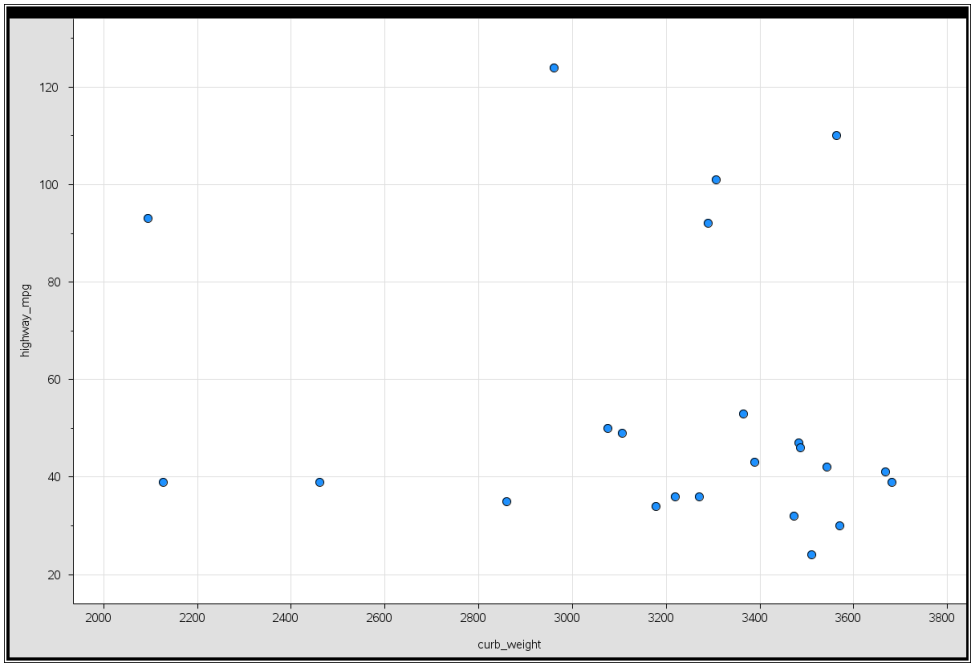


The scatter plots show different configurations that students expected to see once they had the data to plot.

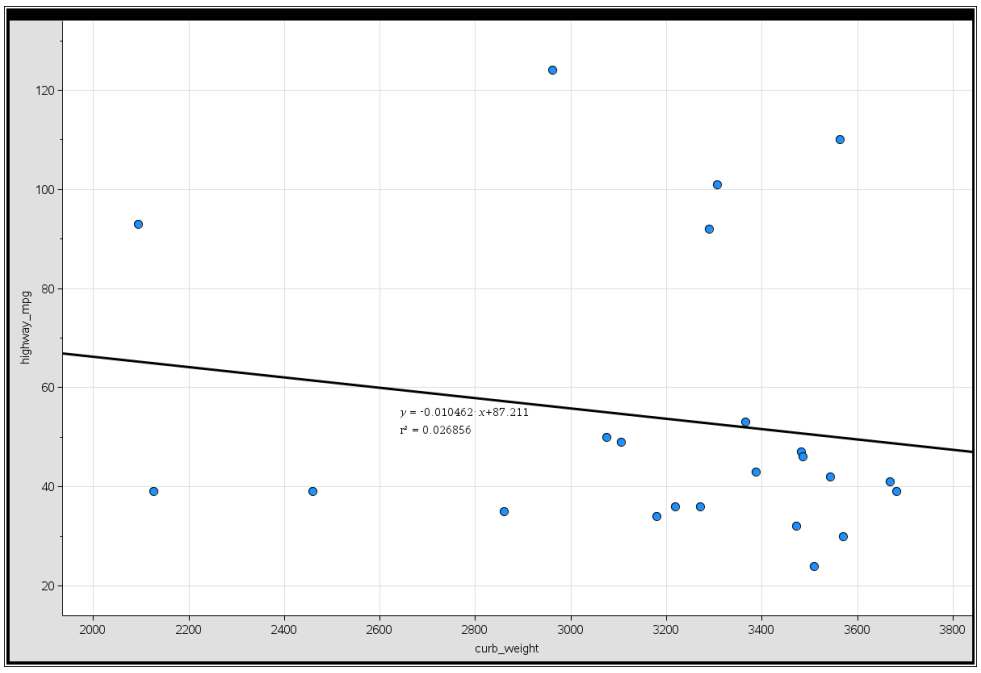
Here is one plot from the Google spreadsheet:



Students analyzed the data using TI-Nspire - it's more powerful and allows for deeper analysis. They all were able to produce this scatter plot



and they were amazed at how weak the correlation is (approximately -0.16) and that the slope of the regression line is approximately -0.01, which makes the line basically flat.



The equation for the regression line is: $\hat{mpg} = -0.01\ weight + 87$.

Student claim statements about car data (Cycle 2)

Car Data - Claim 1

The heavier the car, the lower the mpg.

#1

The fact that hybrid cars have the best correlation supports the claim that heavier cars have a lower highway mpg because the correlation is a measurement of how connected one variable is to the other. With the hybrid having a 0.88 correlation which is very strong this supports the claim true. so what? So this evidence proves that hybrid cars prove the claim that heavier cars have a lower highway mpg.

#2

the fact that some electric cars are the same weight as gas cars but have much better highway mpg refutes the claim that heavier cars will have lower highway mpg because if electric cars that are the same weight as gas cars but have much better mpg that would mean that weight has little to no impact on mpg.

#3

The fact that all of the mpg's are almost the same regardless of the weight refutes the claim that heavier cars will have a lower highway mpg because if that was the case, the slope of the line would have a steep negative trend. Instead the slope of the line is -0.01, meaning it is nearly horizontal. The correlation coefficient also refutes this claim because r= -0.164 , showing that there is almost no correlation (in which case r would equal 0).

#4

The fact that gas powered cars have a high curb weight but, a low highway mpg supports the claim that heavier cars will have a lower highway mpg because if you look at the data electric cars have a large range of mpg numbers, but almost all of them have similar curb weights compared to hybrids and gas powered cars. This shows that they all require the same amount of fuel in order to go the same distance.

#5

The fact that the data shows a very low correlation refutes the claim that heavier cars will have lower highway mpg because there are a lot of outliers that make the data very inconsistent, and thus invalidates the claim.

#6

The fact that a lot of heavy cars have a high mpg and some lighter cars have a very low mpg refutes the claim that heavier cars will have lower mpg because the slope is so small that without extreme weight differences the decrease in mpg basically doesn't exist. the slope is so small that for every 100 pounds you add to a gas powered car you will only lose about 1.7 mpg and hybrid and electric are even lower.

#7

The fact the correlation coefficient of the graph is -0.1 refutes that claim that the heavier cars will have lower highway mpg because a correlation coefficient of -0.1 is a correlation that indicates any relationship could be entirely coincidental, even a random data set could have a stronger correlation. If you actually look at the graph, you will see that according to the 2017 model cars, this claim is absolutely false.

#8

The linear relationship of the slope and correlation coefficient refutes the claim that heavier cars will have lower highway mpg. If the heavier the car the lower the mpg, then the graph should have a linear set of data. What we find tho is there being many outliers making the slope a very small number of -0.01. Which would only work if the difference in mpg to weight were very close but the smallest ratio for one car is 23.6 pounds for every mpg. We see the same thing when looking at the correlation of the data. When all fuel types are grouped together the data has a very poor correlation of -0.164. When fuel types are grouped separately we find each fuel type having a lot stronger correlation closer to 1. Gas has a correlation grouped by itself of -.77 and hybrid has a correlation of -.88 by itself. Electric cars tho still have a bad correlation of -.28. The fuel types being grouped separate help refute the claim because it shows there's no true dictating relationship between highway mpg and curb weight. If there was the correlation shouldn't change that much when the data is grouped in different ways which also proves there to be a lot of outlier having a factor, also refuting the claim that the heavier the car, the less Mpg.

#9

When every fuel type is put into one category to compare curb weight and highway MPG, the correlation is close to zero. This refutes the claim that heavier cars will have lower highway mpg. However, when the fuel types are separated into different categories, the correlation coefficients of each group are farther from zero than the coefficient of the scatter plot that is not separated. This means that the weight and mpg are related.

Car Data - Claim 2

Electric cars will have a lower curb weight (than other cars).

#1

The IQR of electric vehicle curb weight compared to gas refutes the claim that Electric cars will have a lower curb weight. The box plot shows that 25% of the smaller curb weight data of electric cars is greater than 25% of the smaller curb weight data of gas cars. We find the same thing when looking at 50% and 75% of the smaller curb weight data for electric vs gas. This shows that through 75% of the overall data the IQR is higher, meaning that electric cars have an overall greater curb weight compared to gas.

#2

The fact that all of the electric cars but one have weights above 2900 lbs refutes the claim that electric cars will have a lower curb weight because that shows that the gas cars have over three cars that weigh lower than electric cars. Also the median weight of electric cars is 3307 as where the median of the gas cars is 3219 almost a solid 100 lbs lighter than a electric car. All of this data refutes the claim that electric cars will have a lower curb weight because of all the electric cars only one is lighter than gas cars and the gas cars have 3 lighter cars then

the majority of the electric cars, the median weight of the gas cars is almost 100 lbs lighter then the electric cars median.

#3

The fact that the IQR of electric cars (582) is less than the IQR of gas-fueled cars (831) refutes the claim that electric cars will have a lower curb weight because this means that 50% of the electric data is consistently grouped at a higher curb weight than gas-fueled. Furthermore, the highest value in Q3 for electric cars is 3453 and for gas-fueled it is 3491. This automatically disproves the claim because it states that electric cars will have a lower curb weight, meaning that as long as one data point is greater than any of the data for hybrids or gas-fueled cars, than the claim is false. Another point to take this a step further, both Q1 and the median of electric cars have a greater value than that of gas-fueled cars. Along with the provided evidence, many more points can be made that would refute the claim stated above.

Car Data - Claim 3

Gas powered vehicles will have higher highway mpg than electric or hybrid vehicles.

#1

The IQR of electric vehicles refutes the claim that gas powered vehicles have a higher highway mpg than electric or hybrid. The box plot shows that 100% of the IQR of electric vehicles highway mpg is higher than 100% of the highway mpg of gas powered vehicles. This shows that all electric vehicles have a higher mpg than all of the gas powered vehicles. Refuting the claim that gas powered has higher highway mpg than electric or hybrid.

#2

The fact that the minimum of both hybrids (39) and electric cars (42) are greater than or equal to the maximum mpg of gas-fueled cars (39) refutes the claim that gas-fueled cars have a greater highway mpg than hybrids and electric cars because this shows that every data point for the other two categories are greater than every data point for gas-fueled cars. As a matter of fact, a true claim would be the opposite of the one provided. Gas-fueled cars have a lower mpg than hybrids and electric cars. Literally 100% of the data for hybrids and 100% of the data for electric is greater than 100% of the data for gas-fueled cars. To tie this argument off, the average for each category is 34 mpg for gas, 45 mpg for hybrids, and 88 mpg for electric cars. It is no surprise that both averages for the other categories are substantially greater than the average for gas-fueled cars.

Sample student essay about car data (Cycle 2)

Write a five paragraph essay addressing the claims:

1. The heavier the car, the lower the mpg.
2. Electric cars will have a lower curb weight (than non-electric cars).
3. Gas powered vehicles will have higher highway mpg than electric or hybrid vehicles.

Use the work that you've already done, or modify what you've already written, based on the feedback from the class discussion. Be sure to pay attention to the rubric.

Science and Math Practices (Target: Graduation Benchmark)

Below Target	**On Target**	**Above Target**
Analyzes the quality, relevance, and limitations of data, but is unable to build an argument OR argument is flawed Contextual references to specific statistics are flawed or missing Includes no representation of the data	Builds an argument based in evidence with clear reference to the data Contextual references to specific statistics are correct Includes at least one representation of the data to illustrate a point	Makes inferences that move beyond the initial idea Contextual references to specific statistics are correct, clear, and explicit Includes at least one representation of the data to illustrate a point

Statistics & Probability (Target: Progressing)

Below Target	**On Target**	**Above Target**
Represents data with appropriate plots (for both single variables and paired data) Uses statistics appropriate to the shape of the data to compare center and spread of two or more different data sets	Interprets linear models (including slope, intercept, and correlation coefficient) Fits an appropriate model to data that represents two quantitative variables	Conveys a depth of understanding of basic statistical measures as demonstrated through arguments, claims, and interpretations

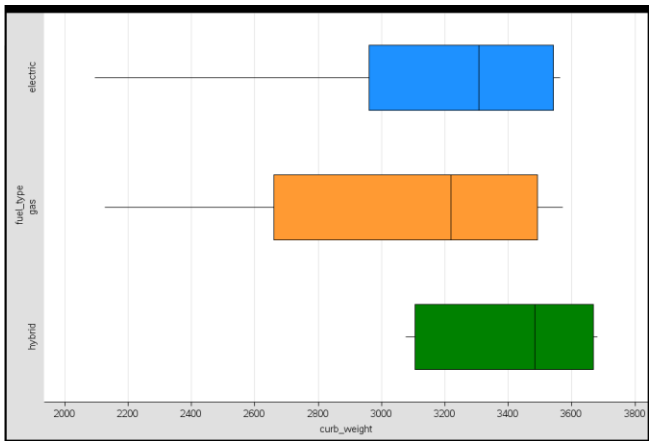
The evidence helps refute the claim that Fuel type has a stronger relationship with highway mpg than curb weight. The subclaims, the heavier the car, the lower the mpg, Electric cars will have a lower curb weight (than non-electric cars) and Gas powered vehicles will have higher highway mpg than electric or hybrid vehicles help reinforce the evidence to refute the overall claim. The reasoning analysis compares measures of range, interquartile range, slope and correlation coefficient of all the 2017 gas, electric and hybrid vehicles. The reasoning behind the analysis will support that the claims are false.

The linear relationship of the slope and correlation coefficient refutes the claim that heavier cars will have lower highway mpg. If the heavier the car the lower the mpg, then the graph should have a linear set of data. What we find tho is there being many outliers making the slope a very small number of -0.01. Which would only work if the difference in mpg to weight were very close but the smallest ratio for one car is 23.6 pounds for every mpg. We see the same thing when looking at the correlation of the data. When all fuel types are grouped together the data has a very poor correlation of -0.164. When fuel types are grouped separately we find each fuel type having a lot stronger correlation closer to 1. Gas has a correlation grouped by itself of -.77 and hybrid has a correlation of -.88 by itself. Electric cars tho still have a bad correlation of -.28. The fuel types being grouped separate help refute the claim because it shows there's no true dictating relationship between highway mpg and curb weight. If there was the correlation shouldn't change that much when the data is grouped in different ways which also proves there to be a lot of outliers having a factor, also refuting the claim that the heavier the car, the less Mpg.

The IQR of electric vehicle curb weight compared to gas refutes the claim that Electric cars will have a lower curb weight. The box plot shows that 25% of the smaller curb weight data of electric cars is greater than 25% of the smaller curb weight data of gas cars. We find the same thing when looking at 50% and 75% of the smaller curb weight data for electric vs gas. This shows that through 75% of the overall data the IQR is higher, meaning that electric cars have an overall greater curb weight compared to gas.

The IQR of electric vehicles refutes the claim that gas powered vehicles have a higher highway mpg than electric or hybrid. The box plot shows that 100% of the IQR of electric vehicles highway mpg is higher than 100% of the highway mpg of gas powered vehicles. This shows that all electric vehicles have a higher mpg than all of the gas powered vehicles. Refuting the claim that gas powered has higher highway mpg than electric or hybrid.

The subclaims, “the heavier the car, the lower the mpg”, “Electric cars will have a lower curb weight (than non-electric cars)” and “Gas powered vehicles will have higher highway mpg than electric or hybrid vehicles.” help the evidence and reasoning refute the overall claim that Fuel type has a stronger relationship with highway mpg than curb weight.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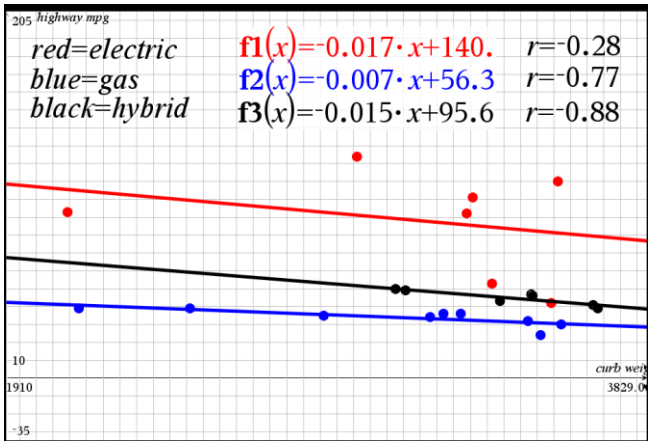
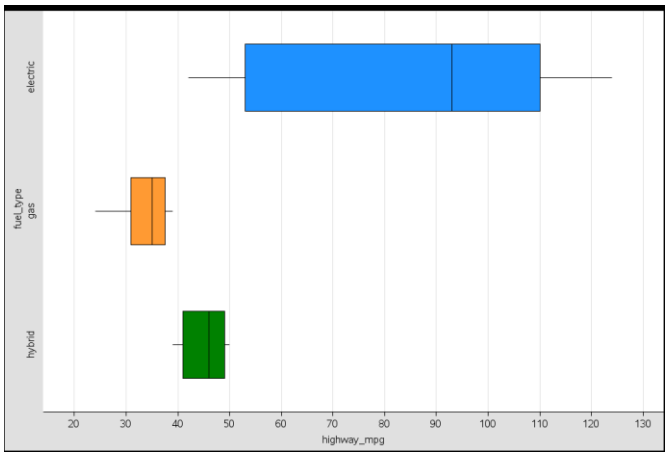
2600
2800
3000
3200
3400
3600
3800
curb_weight


205 highway mpg
red=electric
blue=gas
black=hybrid
f1(x)=-0.017·x+140.
f2(x)=-0.007·x+56.3
f3(x)=-0.015·x+95.6
r=-0.28
r=-0.77
r=-0.88
10
1910
3829.0
-35


electric
fuel_type
gas
hybrid
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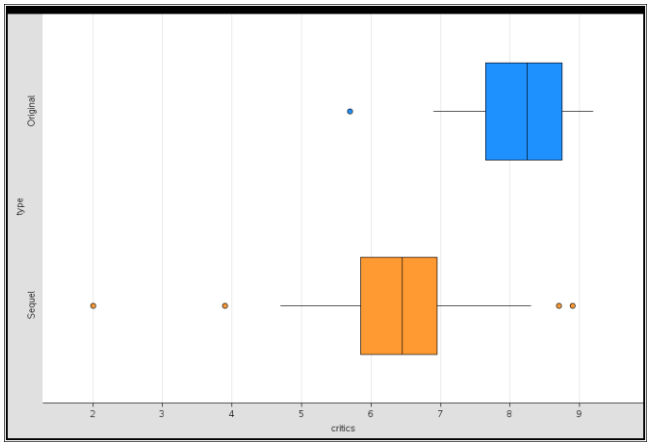
30
40
50
60
70
80
90
100
110
120
130
highway_mpg

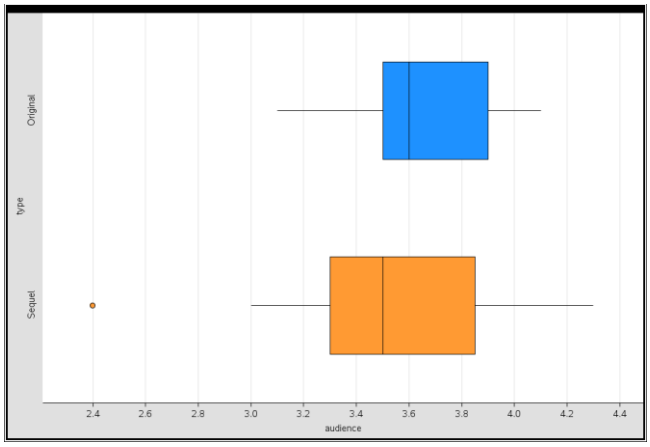
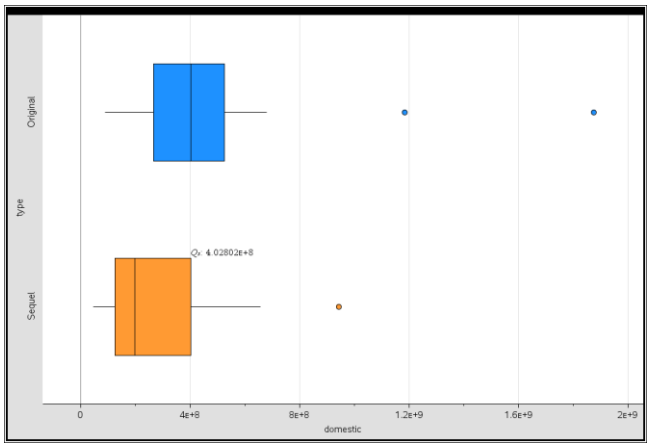
Sample tudent analysis of movie data (Cycle 3)

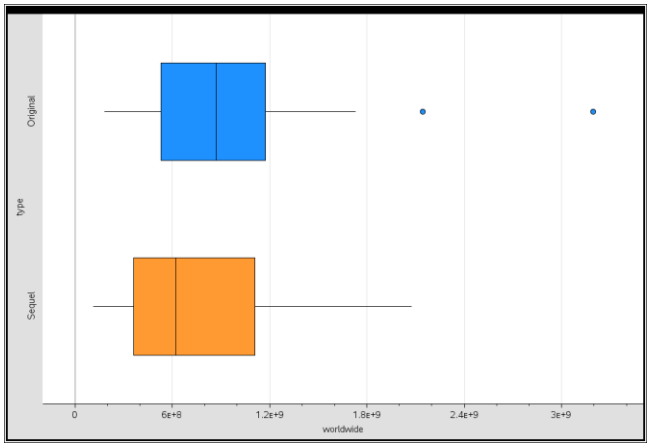
Analyzing Movie Data

April 2017

Pick your claim (and delete the other one). Original movies are better than sequels.
Upon first look at the data, would you say that your claim is supported or not?
If you are comparing original movies to sequels, which variables make sense to use?

Pick a variable and insert an appropriate graph below.	Explain what the graph is illustrating about your claim here. Be sure to cite specific statistics and provide reasoning.
	This Graph shows that the critics prefers the original movies over sequels. Just comparing the medians proves this. The sequels median is 6.45 out of 10, but the originals median is 8.25. There is a 1.8 difference between the two. Even the originals first quartile is at 7.65 and the sequels last quartile is at 6.95, that's a 0.7 difference.

Pick another variable and insert an appropriate graph below.	Explain what the graph is illustrating about your claim here. Be sure to cite specific statistics and provide reasoning.
	A majority of the audience agrees that the original movies are better than the sequels. The original's median is at 3.6, while the sequel's is at 3.5. In fact the originals lowest quartile is the same as the sequels median.
Pick another variable and insert an appropriate graph below.	Explain what the graph is illustrating about your claim here. Be sure to cite specific statistics and provide reasoning.
	The box plot on Domestic score shows that originals were preferred over sequels. Actually, the originals median score of 4.01, is just under the sequels highest quartile, 4.03. The sequels median is at 1.97, that's 3.04 lower than the originals.
Pick another variable and insert an appropriate graph below.	Explain what the graph is illustrating about your claim here. Be sure to cite specific statistics and provide reasoning.

	Even Worldwide originals are prefered. The original median is 4.01 and the sequels have 1.97, a whole 2.04 difference. The first quartile of the originals is 2.65 and the sequel is at 1.25, 0.55 lower. The last quartile for the original is 5.26 but for the sequels it's 4.03.

Sample student class data analysis (Cycle 4)

Class Data Analysis Review

Here are the rubrics. Review the statements on the following pages to determine if they are on target.

Science and Math Practices (Target: Graduation Benchmark)

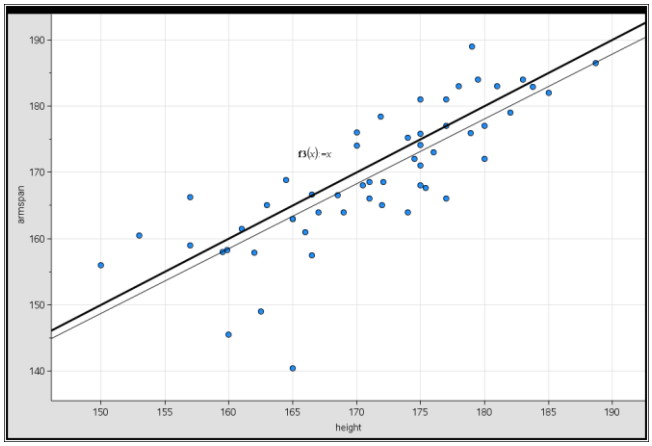
Above Target	On Target	Below Target
Makes inferences that move beyond the initial idea Contextual references to specific statistics are correct, clear, and explicit Includes at least one representation of the data to illustrate a point	Builds an argument based in evidence with clear reference to the data Contextual references to specific statistics are correct Includes at least one representation of the data to illustrate a point	Analyzes the quality, relevance, and limitations of data, but is unable to build an argument or argument is flawed Contextual references to specific statistics are flawed or missing Includes no representation of the data or representation is not appropriate for the data

Statistics & Probability (Target: Progressing)

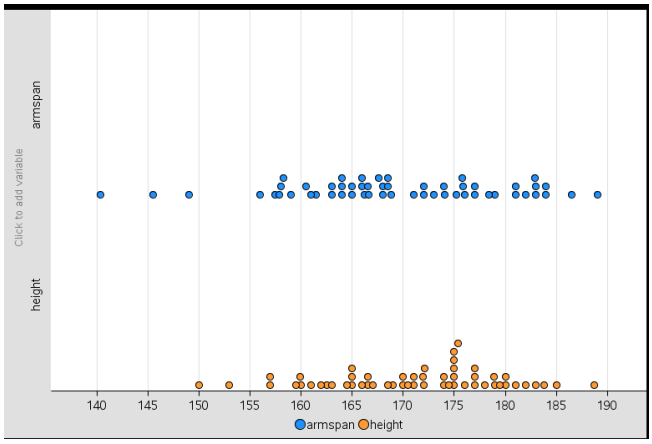
Above Target	On Target	Below Target
Conveys a depth of understanding of basic statistical measures as demonstrated through arguments, claims, and interpretations	Interprets linear models (including slope, intercept, and correlation coefficient) Fits an appropriate model to data that represents two quantitative variables	Represents data with appropriate plots (for both single variables and paired data) Uses statistics appropriate to the shape of the data to compare center and spread of two or more different data sets

Height vs armspan

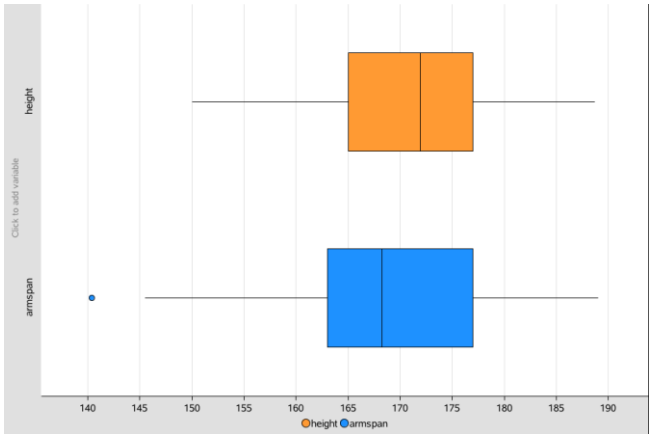
#1

Insert an appropriate graph to illustrate the subclaim: The students heights will be similar to their arm spans.	Explain how the graph supports (or refutes) the subclaim.
	This graph is modeling the height vs. the arm span of the students. The claim the height of the students would be similar to the students arm span is supported by this graph. This is because the bold line is the y=x line. This line is if every student's arm span was exactly equal to the student's height. The line of best fit has a little less slope than the line y=x. This means that there is a similar correlation between the two lines.

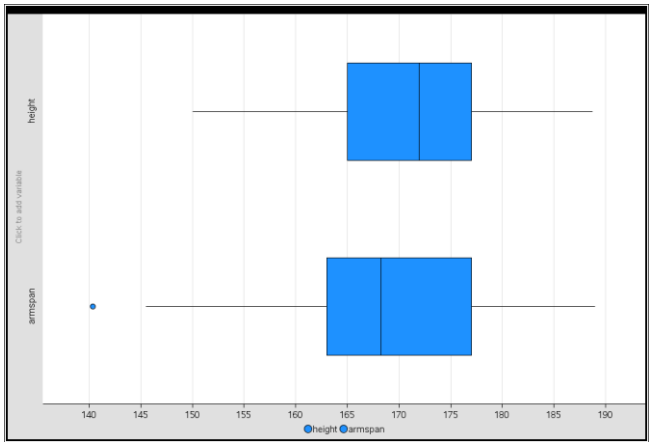
#2

Insert an appropriate graph to illustrate the subclaim: The students heights will be similar to their arm spans.	Explain how the graph supports (or refutes) the subclaim.
	This scatterplot supports the subclaim because it shows that all the data (excluding the outliers) is grouped up between two points (157 and 185) the data could be even closer together if there were less people with drastically different heights. Some specific points to focus on would be the lowest height that isn't an outlier, at 157. On both scatterplots for height and armspan they both have their lowest relevant point between 156 and 157 and the same goes for the maximum relevant length between 184 and 185 which shows how close the arm span can resemble one's height.

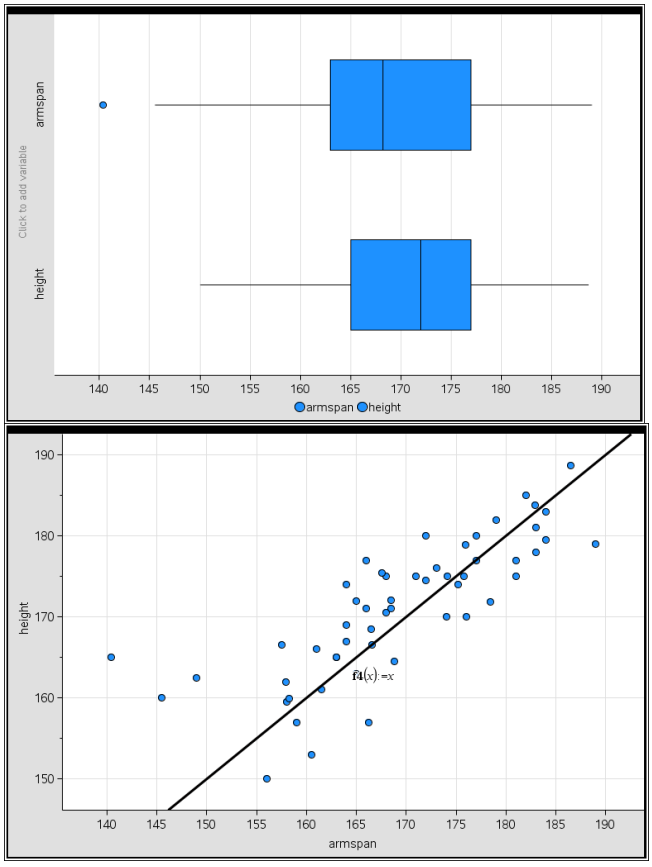
#3

Insert an appropriate graph to illustrate the subclaim: The students heights will be similar to their arm spans.	Explain how the graph supports (or refutes) the subclaim.
	The subclaim supports the claim because the mean of the high's is 179.95 and the mean of armspan is 169.25 proving that the difference between height and armspan is 10 cm.

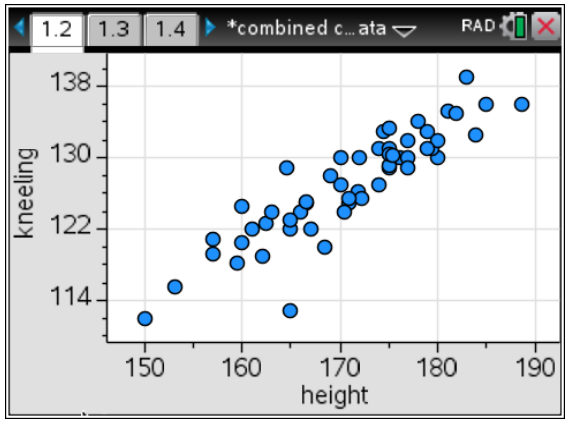
#4

Insert an appropriate graph to illustrate the subclaim: The students heights will be similar to their arm spans.	Explain how the graph supports (or refutes) the subclaim.
	This graph supports the claim that the heights of the students will be similar to their arm spans because the box graphs are way to similar in quartile range and in maximum and fall in the same set of numbers therefore supports of overall claim that human bodies are proportionally sized in a predictable way.

#5

Insert an appropriate graph to illustrate the subclaim: The students heights will be similar to their arm spans.	Explain how the graph supports (or refutes) the subclaim.
	The box plot supports the subclaim that students heights will be similar to their arm spans. As the median for students heights is (168.25 cm) and the median for students arm spans is (171.95 cm.) This is showing that on average, the difference between students heights and arm spans is 3.70 cm, which shows that the height and arm spans on average are very similar to each other. This second graph is also supporting the subclaim that students heights will be similar to their arm spans. Since most of the points are fairly close to the line. The furthest away point has a height of (140.4 cm) while their arm span is (165 cm.) This is only about 25 cm difference. For the point to only have a 25 cm difference and also be the biggest difference between height and arm span supports my claim.

#6

Insert an appropriate graph to illustrate the subclaim: The students heights will be similar to their arm spans.	Explain how the graph supports (or refutes) the subclaim.
	This graph supports the claim because the graph has the strongest correlation. The scatterplot creates a linear almost perfectly, proving that everyone's kneeling height makes up about the same percent of their height.