



# Beyond Multivariable Thinking: Pictures as Data

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# Outline

- Introductory statistics at Montana State
  - Motivation for multivariable data visualization in the intro course
  - What is dollar street?
  - Dollar street assignment
  - Example student submissions
  - Lessons learned
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# Montana State University



MSU  
QUICK  
FACTS

FALL 2017 FRESHMEN:

Montana residents

**50%**

Nonresident students

**50%**

**TOP 10 STUDENT HOME  
STATES**

Montana	<b>9,569</b>	Idaho	<b>390</b>
Washington	<b>1,212</b>	Oregon	<b>359</b>
California	<b>1,033</b>	Alaska	<b>274</b>
Colorado	<b>950</b>	Illinois	<b>214</b>
Minnesota	<b>495</b>	Wyoming	<b>208</b>

**INTERNATIONAL STUDENTS**

670 (FROM 72 COUNTRIES)

**Estimated Cost of Attendance (per year)**

2017 / 2018	<b>Resident</b>	<b>Nonresident</b>
Tuition/Fees	\$7,080	\$24,070
Room/Board	\$9,300	\$9,300
Books/Supplies	\$1,350	\$1,350
Total Estimated Cost	\$17,730	\$34,720

ENROLLMENT  
**16,703**

MONTANA'S  
LARGEST  
UNIVERSITY  
FALL 2017

ESTABLISHED  
**1893**

BOZEMAN, MT

MONTANA'S LAND-GRANT  
UNIVERSITY

FALL 2017 FRESHMEN

Average HS GPA

**3.53**

Average ACT score

**25.2**

Average SAT score

**1213**



MSU BOBCATS

**NCAA DIV 1  
ATHLETICS**

BIG SKY CONFERENCE



# Stat 216: Introduction to Statistics

- Offered through the Department of Mathematical Sciences
- Covers descriptive statistics and statistical inference for one proportion, one mean, two proportions, two means, regression slope
- Largest course on campus – annual enrollment  $\approx$  1,500 students (10% of total student enrollment at MSU)
- 15 – 25 sections of around 40 – 60 students each semester
- Primarily taught by Statistics MS and PhD students and non-tenure-track faculty
- 3-credit course – MWF for 50 min or TR for 75 min for 15 weeks

# Stat 216: Curriculum, Pedagogy, and Technology

- Simulation-based curriculum
- *Introduction to Statistical Investigations*, Tintle, Chance, Cobb, Rossman, Roy, Swanson, & VanderStoep (2016)
- Entirely flipped class
- ISI web applets, Tableau



# Poll

Which of the following technology tools do you use in the intro stats classroom for data visualization?

(Select all that apply)

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# Multivariable Thinking in Tableau

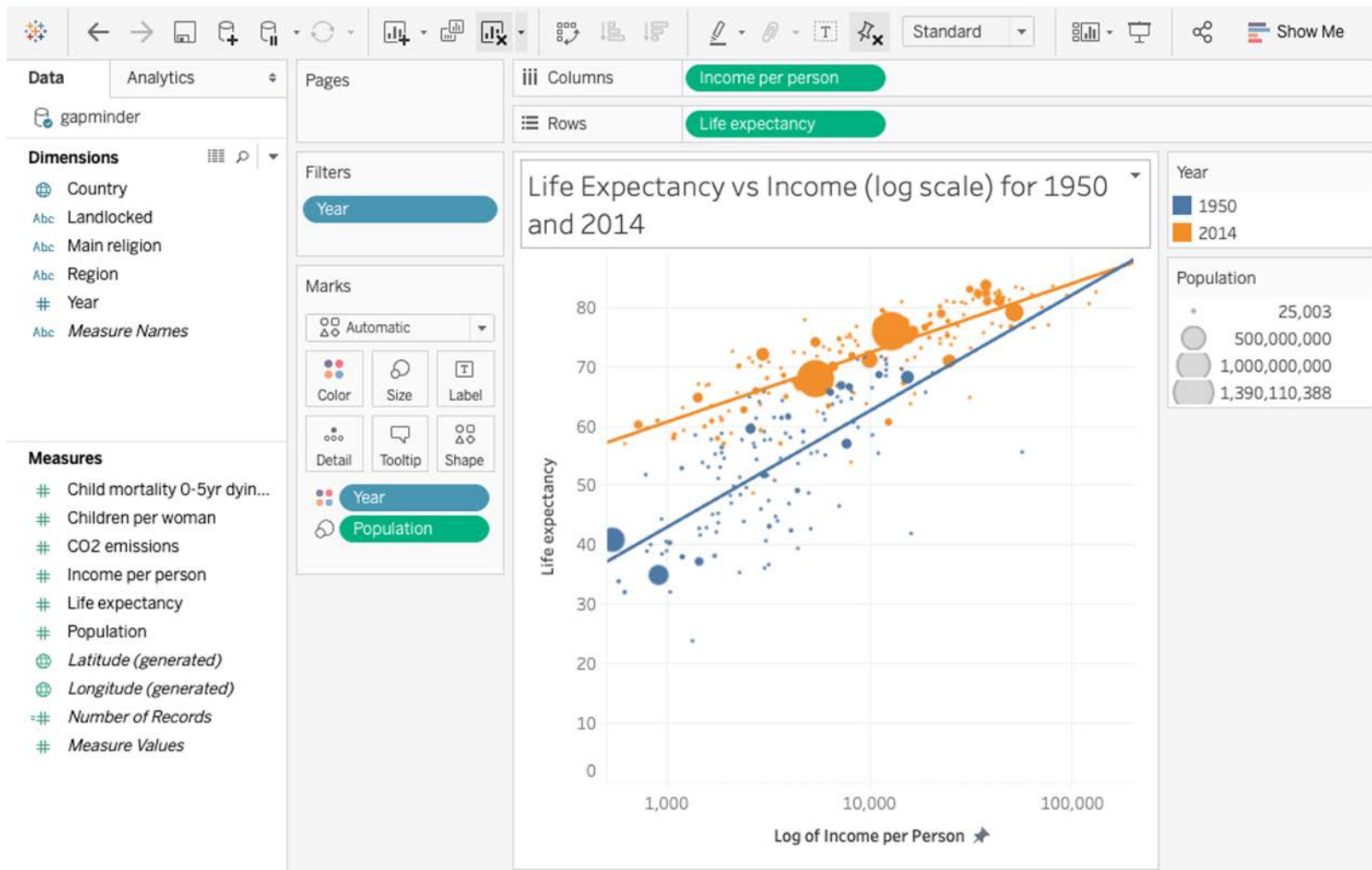
*Guidelines for Assessment and Instruction in Statistics Education College Report 2016*

Recommendation 1: Teach statistical thinking.

- ★ Give students experience with **multivariable thinking**:

- “We must prepare our students to answer challenging questions that require them to investigate and explore relationships among many variables.”





# Poll

How familiar are you with Dollar Street?

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# A Tour of Dollar Street

<https://www.gapminder.org/dollar-street/matrix>



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# Using photos as data to understand how people live

TED Talk  
by Anna  
Rosling  
Rönnlund





# Why use photos as data?

*“You would never accept someone to talk about stereotypes of your own country, grouping it all into one country, but we do that all the time when it comes to other countries.” - Anna Rosling Rönnlund*

- Statistics focus on summary measures and miss the diversity within a single country.
- In reality, the gap between the poor and the rich is much larger than the gap between two different countries.
- We don't really understand the living conditions and socio-economic aspects of a country until you actually see it.



# Dollar Street Assignment

## Learning Outcomes

1. Identify the **observational units** in a study.
2. Identify a variable and determine whether the variable is **quantitative or categorical**.
3. Create an **appropriate type of plot for one, two, or multiple variables** based on the types of variables (quantitative or categorical) and their roles (explanatory or response).
4. Gain **information from a plot and summarize**.
5. Reflect on the type of information that cannot be discovered through quantitative or categorical variables, and **how pictures can give one insight into a data set**.



# Dollar Street Assignment

## Suggested Use and Key Questions

### Suggested Use:

- Week 2 out-of-class assignment
- Collaborative work allowed, individual submissions required
- Could also be used in the classroom (#1 - 4 completed as preparation for class)

### Key Questions:

- Distinction between observational units (#1 - Dollar Street vs. #5 - Gapminder)
- Multivariable thinking and interactions (#13)
- Comparison across countries vs. across income brackets (#14)

# Dollar Street Assignment

Available for download at <https://bit.ly/eCOTSdollarstreet>





## Beyond Multivariable Thinking: Pictures as Data

### Activity

In this activity, you will use Tableau to re-create some data visualizations using world data from gapminder.org. We will then explore pictures as data on Gapminder's Dollar Street (<https://www.gapminder.org/dollar-street>).

First, watch the following TEDx talk, "Using photos as data to understand how people live," from the beginning of the video through time 11:50:

<https://www.gapminder.org/videos/using-photos-as-data-to-understand-how-people-live/>

Answer questions 1-4 about this video.

1. What are the observational units on Dollar Street? (Select one)
  - A. Income
  - B. People
  - C. Households
  - D. Countries
2. For each home on Dollar Street, how many categories/things do photographers capture by photo?
3. In order for the number of homes on Dollar Street to be proportional to the world population, out of 100 homes, we need \_\_\_\_\_ homes from Asian countries.
4. Using the picture data on Dollar Street, Anna Rosling Rönnlund demonstrates that two households from different countries at the same income level generally have [more or less?] in common than two households from different income levels within the same country. (Select one)
  - A. More
  - B. Less

8. Do regions differ in the distribution of main religion among countries? Create a segmented bar graph that allows us to compare the distribution of main religion within regions in 2014. To only plot data from 2014, drag Year to Filter, make sure 2014 is the only box checked, and click OK. Ensure the legend is visible.
9. Use your segmented bar graph to determine which region has the highest percentage of countries where Muslim is the main religion. What is this percentage?
10. Go to the Dollar Street data (<https://www.gapminder.org/dollar-street>). Click the drop-down menu for Families and search for Worship Places. Select four families (one from each region) that 'live' in a similar place on the Dollar Street. Write a sentence or two comparing the places of worship for the four families and provide a screenshot of the picture of Worship Places for each selected family. *Hint: you can use the drop-down menu for 'the World' to select one region at a time to ensure you pick a family from each region.*

Families compared:

Income range for families compared:

Comparison of places of worship:

Pictures of Worship Places chosen:

13. We now want to see if a relationship exists between income per person and life expectancy, and determine if that relationship has changed between 1950 and 2014.
- a) Create a scatterplot to answer this question with income per person on the x-axis and life expectancy on the y-axis. Filter to only show the years 1950 and 2014, color the scatterplot by year and size the points on the scatterplot based on the country's population. Add a logarithmic trend line for each year to the plot as well. Ensure the legend is visible.

*Hint 1: We would prefer to assess linear trends rather than logarithmic trends. We can do this by plotting income per person on the log-scale. In Tableau, right-click on the x-axis and click Edit axis. In the General tab, Change Range to Fixed with a starting point of 200 and end point of 200,000. Check the box for Logarithmic under Scale. Change the title to Log of Income Per Person.*

*Hint 2 (optional): On the Marks card, under Shape, you may choose to have your points filled and under Size, you can use the slider to increase the size of the points to see countries more easily*

- b) Write a short paragraph summarizing the information displayed in this plot.
- c) Does it appear that  $\log(\text{income per person})$  in 2014 is more impactful, less impactful, or has about the same impact on life expectancy as it did in 1950?
- A. More impactful
  - B. Less impactful
  - C. About the same amount of impact

What features of the plot are you using to determine your answer? Explain.

14. Select one 'topic' that was photographed for The Dollar Street that has not been previously discussed in this activity.

Topic:

- a) Select three families from different countries with similar incomes. Write a sentence or two comparing the topic for those three families and provide screenshots of the pictures selected.

Income range:

Countries:

Comparison of pictures:

Pictures selected:

- b) Select three families from the same country with different incomes (one on the low end, one in the middle, one on the high end). Write a sentence or two comparing the topic for those three families.

Country:

Incomes:

Comparison of pictures:

Pictures selected:

Do there appear to be larger differences between the families in (a) or the families in (b)? Explain.





## Example Student Submissions: Comparison of Places of Worship

Most of the families, with the exception of the Mezei family, had very similar places of worship, a small space with spiritual objects in their own homes. None of the families seemed to attend a congregational location of worship such as families with higher incomes were able to, and the Mezei family of Romania had no place of worship at all.

It seems that the two families with the least amount of money out of the four have the more elaborate places of worship despite their lower places on Dollar Street. The two families with more income per month only have a small piece of wall decor and a religious text.

All of the places of worship are relatively similar in the sense that they are not too fancy or extravagant yet they are still rich in design but are not over the top. They all belong in the same group so to speak.




## Example Student Submissions: Multivariable Thinking

The slope of the line is less extreme. That is, lower income populations today have a higher life expectancy than they did in the 1950's, but the higher income populations converge to having nearly the same life expectancy.

The slope of the trend-line for life expectancy in 2014 is smaller than that of the 1950 trend-line. This indicates that as life expectancy increase, income per person increases at a less drastic rate from those in 2014 than those in 1950.

The slope of logarithmic trend line in the year 2014 is more shallow than the slope of the trend line for 1950. This indicates that, in 2014, an increase in income per person leads to less of an increase in life expectancy than the same increase would in 1950.



## **Example Student Submissions: Comparison of a Topic of their Choice**

All three are the exact same animal (pig). I used the slider to limit the income range, and then looked at the whole world. Many of the photos for meat are of living animals (pigs, chickens, duck, etc.). This income level has no way to preserve food, so the animal is alive.

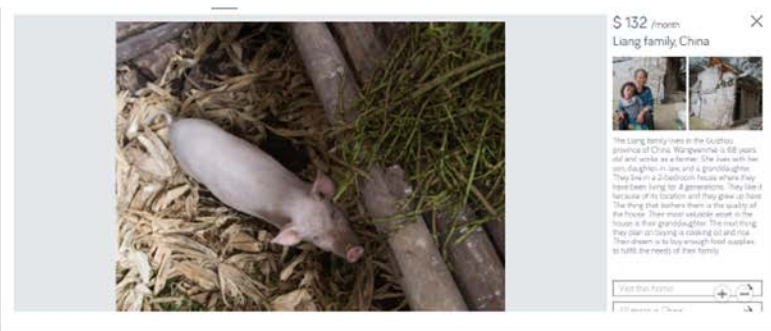


\$131 /month  
Wayan family, Indonesia

The Wayan family lives in the Bali province of Indonesia. They are 52 years old and have two sons and a daughter. They live in a 100-year-old house and have been living there for 5 years. The next thing they plan on doing is building a new house and then a bigger house.

Visit this home

Go around in 30 seconds

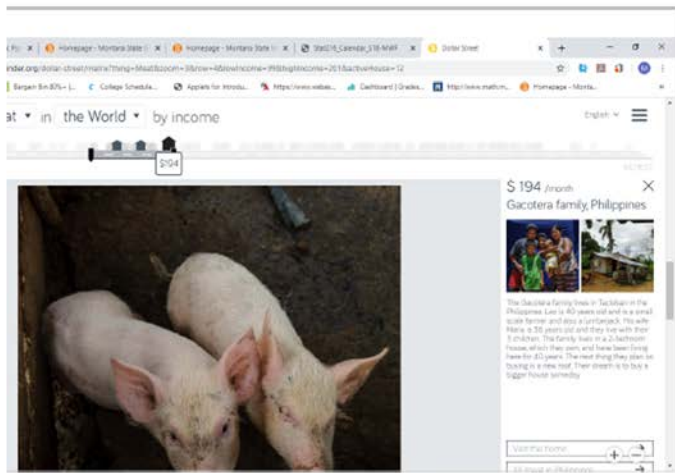


\$132 /month  
Liang family, China

The Liang family lives in the Guangdong province of China. They are 68 years old and have two sons and a daughter. They live in a 100-year-old house and have been living there for 5 years. The next thing they plan on doing is building a new house and then a bigger house.

Visit this home

Go around in 30 seconds

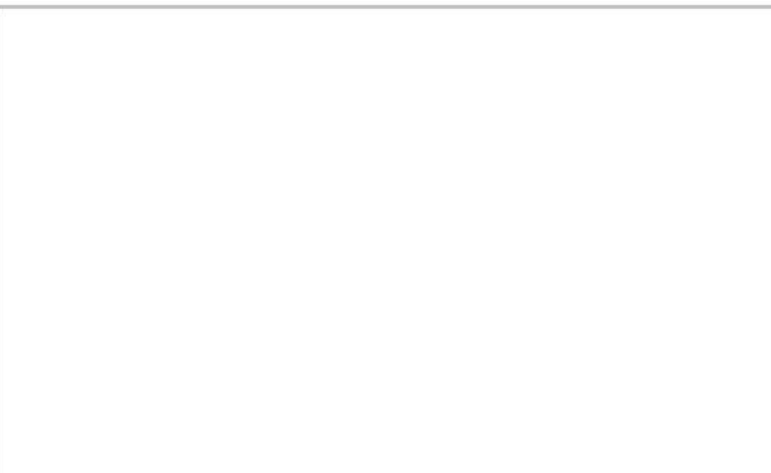


\$194 /month  
Gacotera family, Philippines

The Gacotera family lives in the Philippines. They are 40 years old and have two sons and a daughter. They live in a 100-year-old house and have been living there for 5 years. The next thing they plan on doing is building a new house and then a bigger house.

Visit this home

Go around in 30 seconds



\$194 /month  
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Visit this home

Go around in 30 seconds






Most of the pictures show a huge similarity in bathroom doors for that income range. Most of the pictures have plastic draped over branches for a little privacy while the one in Burkina Faso has mud walls and a metal door. None of the bathrooms have locks.


## Pictures selected:

Bathroom doors • in The Americas & Tanzania • by income

\$102/month  
Guspe de Tanciro family, Peru




Visit this location →  
All locations → Peru




The Guspe de Tanciro family lives in the old town of Tanciro, Peru. They are a small family with 10 children and 1 adult. They are currently in a small, circular, earthen structure with a black plastic sheet draped over a wooden frame for privacy.

Bathroom doors • in Europe & Tanzania • by income

\$163/month  
Mezei family, Romania




Visit this location →  
All locations → Romania




The Mezei family lives in a small, makeshift structure made of plastic sheets and a metal door. They are currently in a small, makeshift structure made of plastic sheets and a metal door. They are currently in a small, makeshift structure made of plastic sheets and a metal door.

Bathroom doors • in Asia & Tanzania • by income

\$45/month  
Raju family, Myanmar




Visit this location →  
All locations → Myanmar




The Raju family lives in a small, earthen structure with a green plastic sheet draped over a wooden frame for privacy. They are currently in a small, earthen structure with a green plastic sheet draped over a wooden frame for privacy.

Bathroom doors • in Africa • by income

\$56/month  
Zongo family, Burkina Faso



Visit this location →  
All locations → Burkina Faso




The Zongo family lives in a small, earthen structure with a metal door. They are currently in a small, earthen structure with a metal door. They are currently in a small, earthen structure with a metal door.

In the lowest income household, they have a door, but no lock and the bathroom is outside (not inside the house). In the middle and upper class pictures, they both have doors and locks, but the door in the higher income range was much nicer quality.

## Pictures selected:

Bathroom doors • in: Europe & Tanzania • by income

\$ 3,579 / month  
Lokonen family, Latvia




The Lokonen family lives in a typical Latvian house, featuring a wooden door and a lock. The house is located in Latvia, a country in the Baltic region of Europe. The family consists of a mother, a father, and two children. They are a middle-class family with a stable income. The house is well-maintained and has a modern interior. The door is made of high-quality wood and has a sturdy lock. The family is happy and healthy, and they enjoy their life in Latvia.

View this income →  
All photos →

Bathroom doors • in: Europe & Tanzania • by income

\$ 10,460 / month  
Farnsworth family, United Kingdom




The Farnsworth family lives in a modern, high-quality house in the United Kingdom. The house is located in a suburban area and has a large garden. The family consists of a mother, a father, and two children. They are a middle-class family with a stable income. The house is well-maintained and has a modern interior. The bathroom is made of high-quality materials and has a glass shower door. The family is happy and healthy, and they enjoy their life in the United Kingdom.

View this income →  
All photos →

Bathroom doors • in: Europe & Tanzania • by income

\$ 476 / month  
Krivko family, Ukraine




The Krivko family lives in a small, dilapidated wooden building in Ukraine. The building is made of old wood and has a green door. The family consists of a mother, a father, and two children. They are a low-income family with a very low income. The building is in poor condition and has no lock. The bathroom is outside the building. The family is struggling and has a difficult life.

View this income →  
All photos →

Bathroom doors • in: Europe & Tanzania • by income

\$ 0 / month  
Family, Tanzania



The family lives in a simple, open wooden door in Tanzania. The door is made of wood and has no lock. The bathroom is outside the house. The family is a low-income family with a very low income. They are struggling and have a difficult life.

View this income →  
All photos →

All of the toys I observed were pretty similar. Only huge difference was in the wear of the toy. Lower income houses had more worn toys while the higher income homes had cleaner, more new looking toys.

Pictures selected:





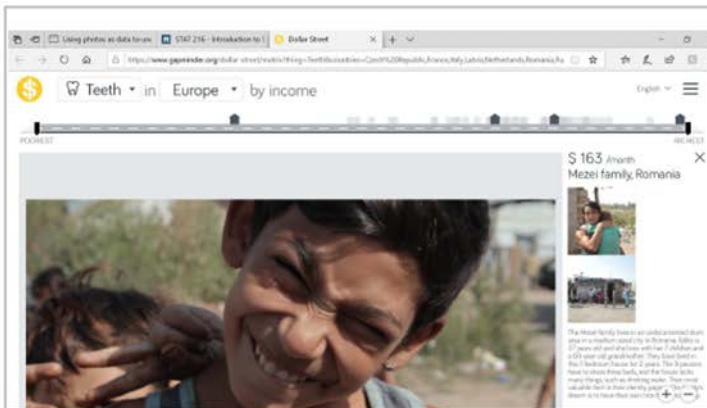
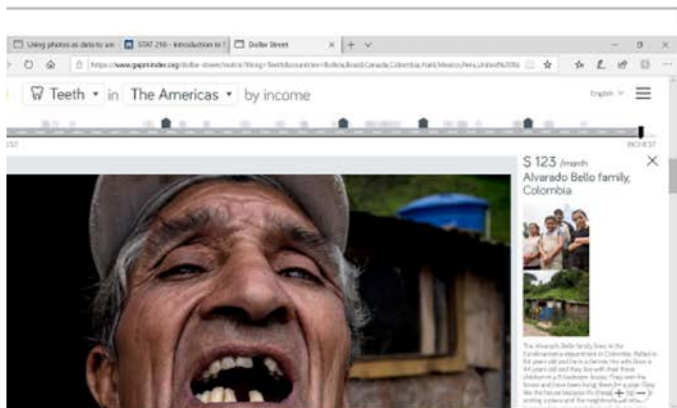
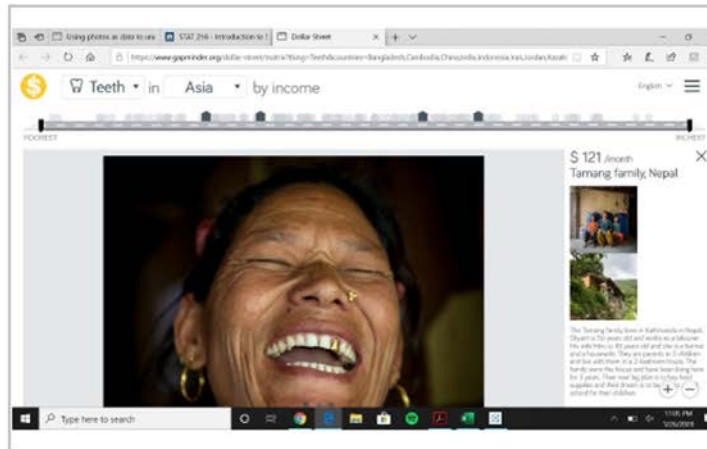
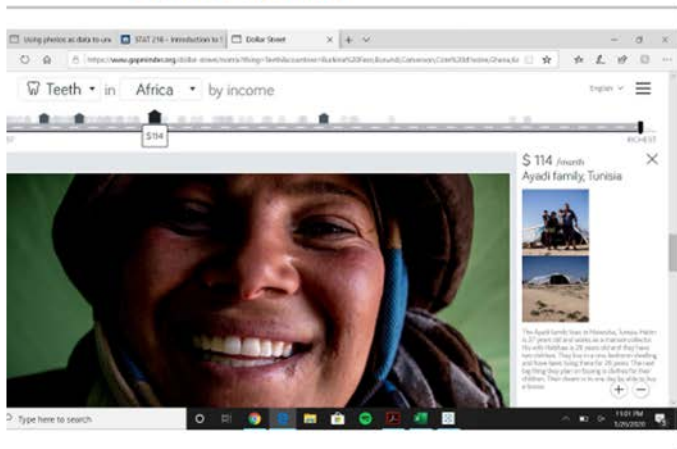
The lowest income family had a broken tv that was used as a toy. As the income increased the quality of the toy also increased. The highest income family had 2 toys in the picture, both of which looked brand new.

Pictures selected:



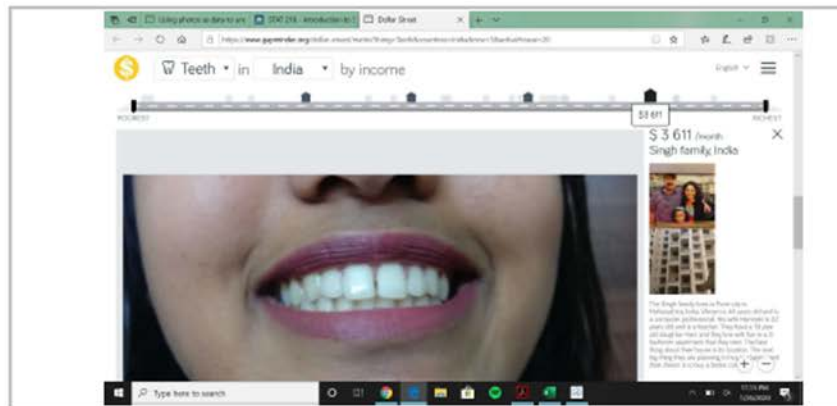
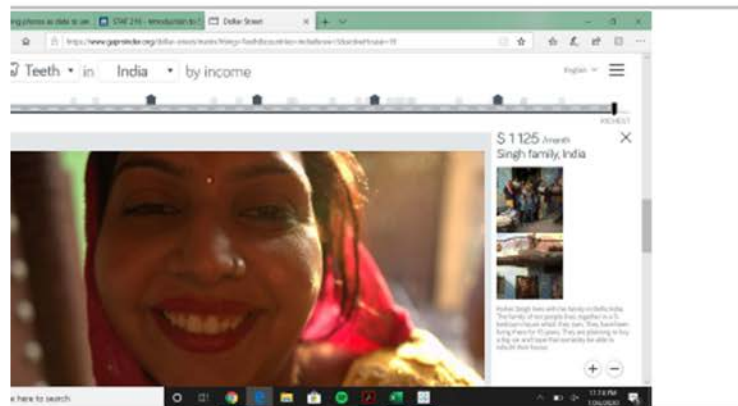
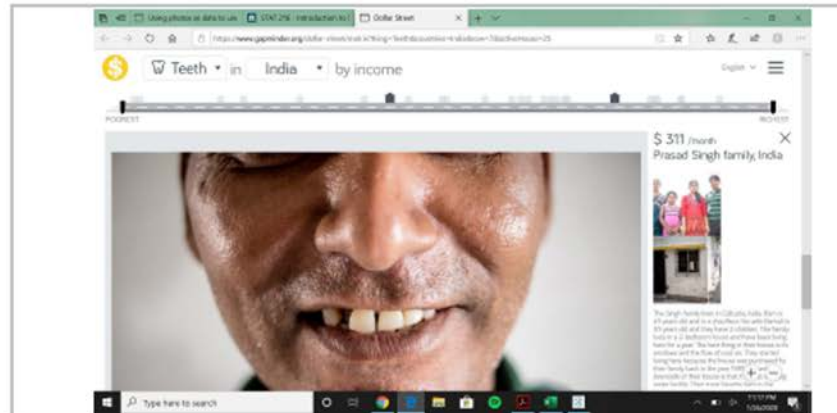
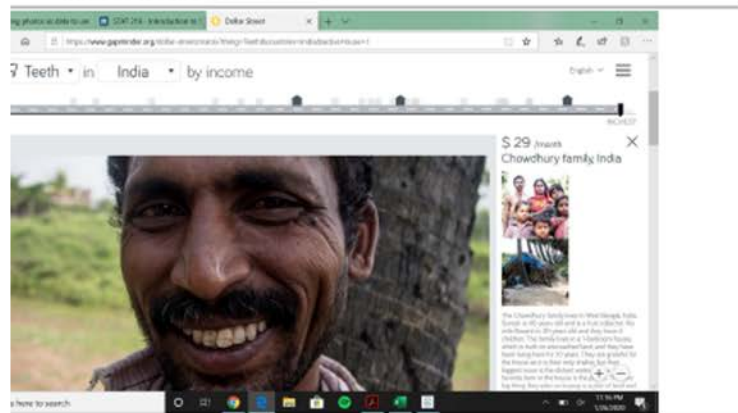
The people from Tunisia, Nepal, and Romania all have relatively nice teeth that are pretty straight and white. The man from Colombia seems to have the worst teeth although his income is in the middle of the range.

Pictures selected:



In this comparison, it is relatively easy to tell the hierarchy of income by each person's teeth. It is much easier to tell the distinction between incomes based on each person's teeth within one country rather than comparing multiple countries.

## Pictures selected:



Soccer is a universal language. In all of these different countries are different balls, all full of air. The ball in the top left is the nicest of all these balls, and comes from the richest family, however still extremely outdated. Any one of these kids kicking the ball could be the next Messi or Cristiano Ronaldo, given the right equipment and opportunity, they could shine!

Pictures selected:







## Lessons Learned

- Overall positive feedback from students
- Dollar Street 'neighbors' was not clear to students
- Require students to choose countries other than the US
- Ban topics you may not want students comparing in an educational setting
- Add a reflection question
  - Reflecting on this activity, write one advantage to using the categorical and quantitative variables in this data set for gaining information about the world, and one disadvantage. Do the same for the picture data.
- Talk about other examples of images as data, e.g., self-driving cars

# Thank you!

Available for download at <https://bit.ly/eCOTSdollarstreet>

## Questions?

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