How engaging with real data can improve students' engagement and learning of statistics topics in Grades 6-12

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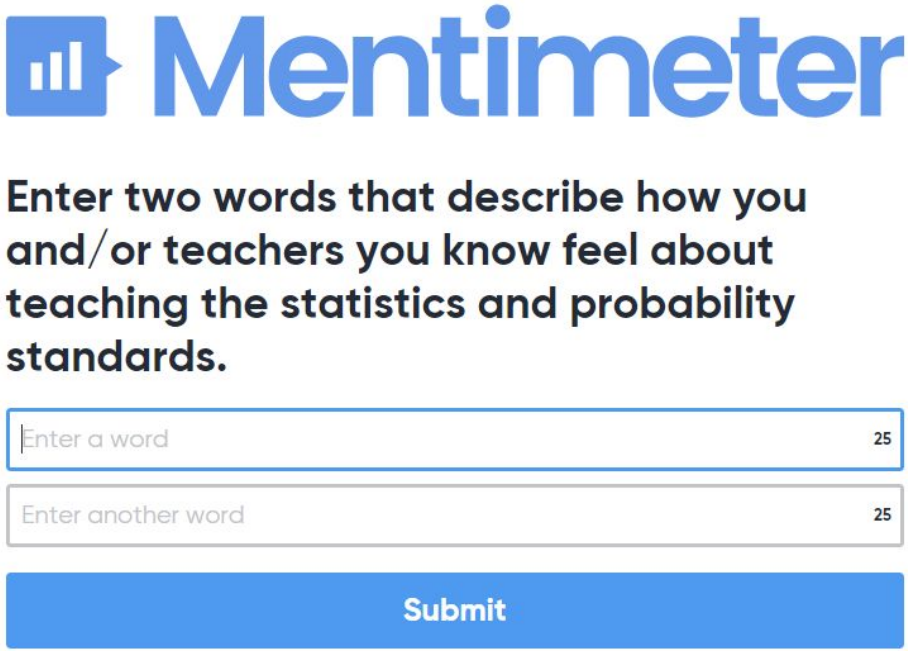


Top Skills Companies Need Most in 2018

- Cloud and Distributed Computing
- **Statistical Analysis and Data Mining**
- Middleware and Integration Software
- Web Architecture and Development Framework
- User Interface Design
- Software Revision Control Systems
- **Data Presentation**
- SEO/SEM Marketing
- Mobile Development
- Network and Information Security

- Leadership
- **Communication**
- **Collaboration**
- Time Management

https://www.linkedin.com/pulse/skills-companies-need-most-2018-courses-get-them-paul-petrone/

What is a Statistician?

Statisticians practice the science of using data to make decisions. They decide what data they need and how to collect it, design experiments, collect data, analyze and interpret data, and report conclusions. And unlike most professions, statistics can be applied to a vast number of fields or issues, like the environment, public safety, health care and sports. As the famous mathematician and statistician John Tukey once told a colleague, "The best thing about being a statistician is that you get to play in everyone's backyard."

https://money.usnews.com/careers/best-jobs/statistician

Creating Data Literate Citizenry

"Data are abundant, quantitative information about the state of society and the wider world is around us more than ever. Paradoxically, recent trends in the public discourse point towards a post-factual world that seems content to ignore or misrepresent empirical evidence. **As statistics educators we are challenged to promote understanding of statistics about society.** In order to re-root public debate to be based on facts instead of emotions and to promote evidence-based policy decisions, statistics education needs to embrace two areas widely neglected in secondary and tertiary education:

understanding of multivariate phenomena and

the **thinking with and learning from complex data**." (Engel, 2017, p. 1)

http://iase-web.org/documents/SERJ/SERJ16(1)_Engel.pdf

Curricula opportunities to develop data literacy

Sample Next Generation Science Standards

MS-LS2-1 Ecosystems: Interactions, Energy, and Dynamics **Analyze and interpret data** to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.

MS-ESS1-3 Earth's Place in the Universe **Analyze and interpret data** to determine scale properties of objects in solar system.

MS-ESS2-3 Earth's Systems **Analyze and interpret data** on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of the past plate motions.

HS-PS3-1 Energy **Create a computational model** to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.

HS-PS3-4 Energy **Plan and conduct an investigation** to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system

HS-PS4-1 Waves and their Applications in Technologies for Information Transfer **Use mathematical representations to support a claim regarding relationships** among the frequency, wavelength, and speed of waves traveling in various media.

Sample ELA standards

CCSS.ELA-LITERACY.RH.6-8.7 Integrate **visual information** (e.g., in **charts, graphs,** photographs, videos, or maps) with print and digital texts.

CCSS.ELA-LITERACY.RST.11-12.3 **Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks**; analyze the specific results based on explanations in the text.

CCSS.ELA-LITERACY.RST.11-12.7 **Integrate and evaluate multiple sources** of information presented in diverse formats and media (e.g., **quantitative data, video, multimedia**) in order to address a question or solve a problem.

CCSS.ELA-LITERACY.RST.11-12.8 Evaluate the **hypotheses, data, analysis, and conclusions** in a science or technical text, **verifying the data** when possible and corroborating or challenging conclusions with other sources of information.

Sample Standards in Social Studies

1. **Define and frame questions about events and the world in which we live, form hypotheses** as potential answers to these questions, **use evidence** to answer these questions, and consider and analyze counter-hypotheses.
2. **Identify, describe, and evaluate evidence** about events from diverse sources (including written documents, works of art, photographs, **charts and graphs**, artifacts, oral traditions, and other **primary and secondary sources**).
3. **Identify causes and effects** using examples from different time periods and courses of study across several grade levels.
4. **Identify, analyze, and evaluate relationship** between multiple causes and effects
5. **Distinguish between long-term and immediate causes** and multiple effects (time, continuity, and change)

Sample Common Core Mathematics Standards

CCSS.MATH.CONTENT.HSS.ID.A.2 Use statistics appropriate to the **shape of the data distribution to compare center** (median, mean) and spread (interquartile range, standard deviation) of **two or more different data sets.**

CCSS.MATH.CONTENT.HSS.ID.A.3 Interpret differences in shape, center, and spread in the context of the data sets, **accounting for possible effects of extreme data points (outliers)**.

CCSS.MATH.CONTENT.HSS.ID.B.6 **Represent data on two quantitative variables** on a scatter plot, and describe how the variables are related.

CCSS.MATH.CONTENT.HSS.ID.B.6.A **Fit a function to the data;** use functions fitted to data to solve problems in the context of the data.

CCSS.MATH.CONTENT.HSS.ID.B.6.B Informally **assess the fit** of a function by plotting and analyzing residuals.

CCSS.MATH.CONTENT.HSS.ID.C.7 **Interpret** the slope (rate of change) and the intercept (constant term) of a linear model in **the context of the data**.

SECONDARY MATH I // MODULE 9
MODELING DATA – RSG 9.1

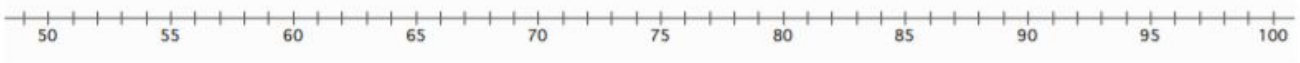
9.1

SET

Topic: Examining data distributions in a box-and-whisker plot.

6. Make a box-and-whisker plot for the following test scores.

60, 64, 68, 68, 72, 76, 76, 80, 80, 80, 84, 84, 84, 84, 88, 88, 88, 92, 92, 96, 96, 96, 96, 96, 96, 96, 100, 100



7 a. How much of the data is represented by the box?

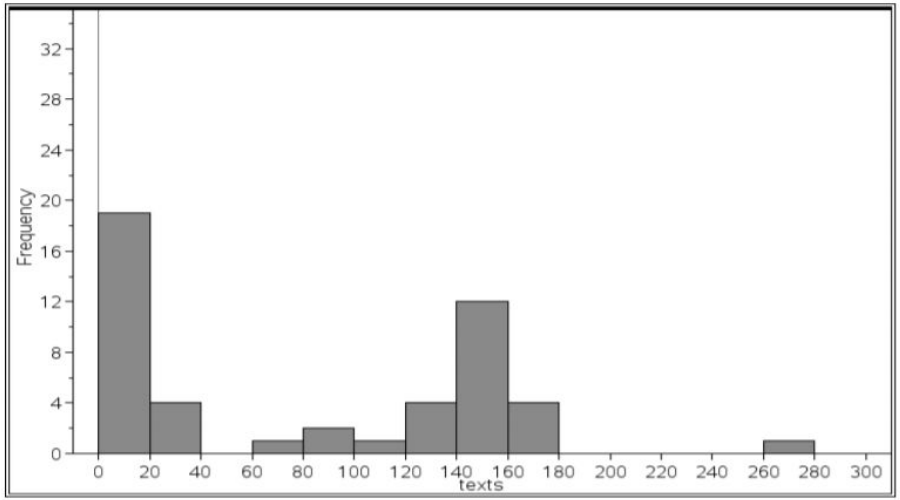
b. How much is represented by each whisker?

8. What does the graph tell you about student success on the test?

https://www.mathematicsvisionproject.org/uploads/1/1/6/3/11636986/m1_mod9_se_62016f.pdf

Technology changes quickly and yet has a large impact on our lives. Recently, Rachel was busy chatting with her friends via text message when her mom was trying to also have a conversation with her. Afterward, they had a discussion about what is an appropriate number of texts to send each day. Since they could not agree, they decided to collect data on the number of texts people send on any given day. They each asked 24 of their friends the following question: "What is the average number of texts you SEND each day?" The data and histogram representing all 48 responses:

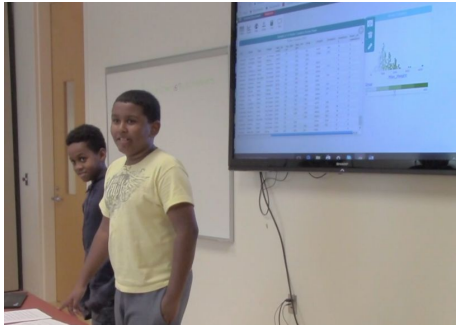
{0, 2, 3, 3, 5, 5, 5, 5, 5, 5.5, 6, 6, 6, 10, 12, 13, 15, 15, 16, 20, 25, 35, 36, 70, 80, 85, 110, 130, 137, 138, 138, 140, 142, 143, 145, 150, 150, 150, 150, 150, 150, 150, 155, 162, 164, 165, 175, 275}

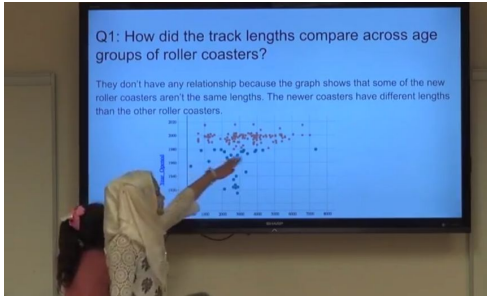


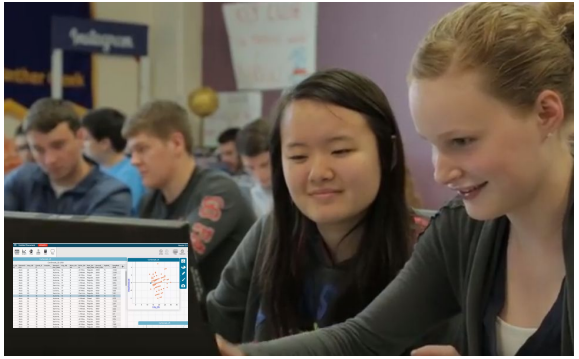
- Fake "Real" data given
- Mostly less than 50 values
- Graphs given or asked to draw by hand
- Focus on structure of graph and not context

https://www.mathematicsvisionproject.org/uploads/1/1/6/3/11636986/m1_mod9_se_62016f.pdf

Investigating Real Data Could Look Like ...

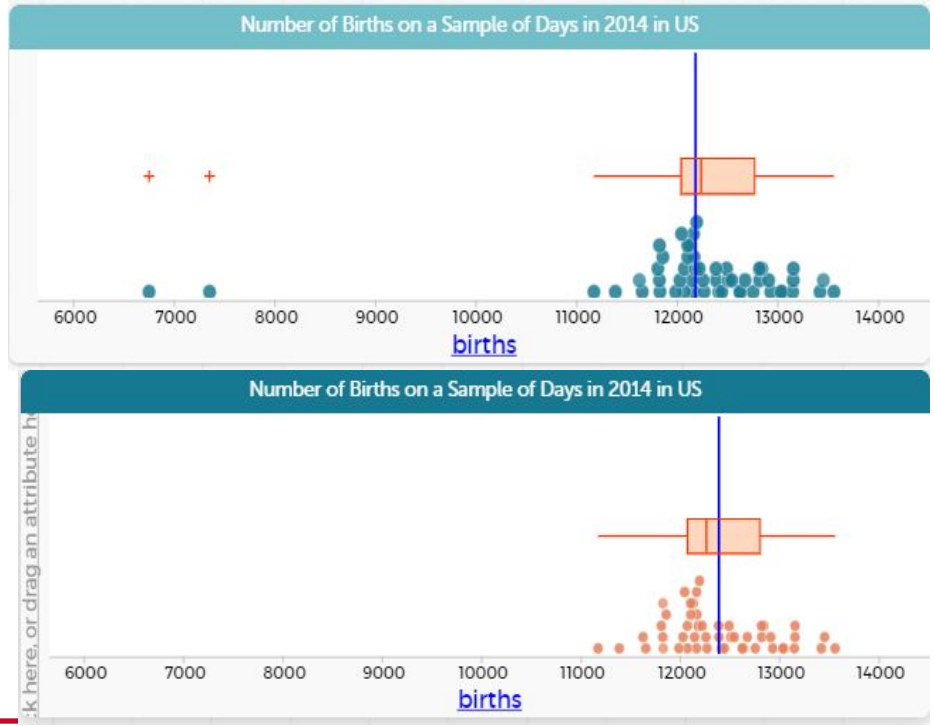






Typical Data Experience in Schools

- Given small data set (or graph) of one (maybe 2) variables.
- Often graph by hand or on a graphing calculator
- Taught to think: “median is slightly bigger than mean. *there are outliers, they pull down my mean. Lets get rid of them and recompute mean.”*
- Report typical number of births per day as average of 12,387.



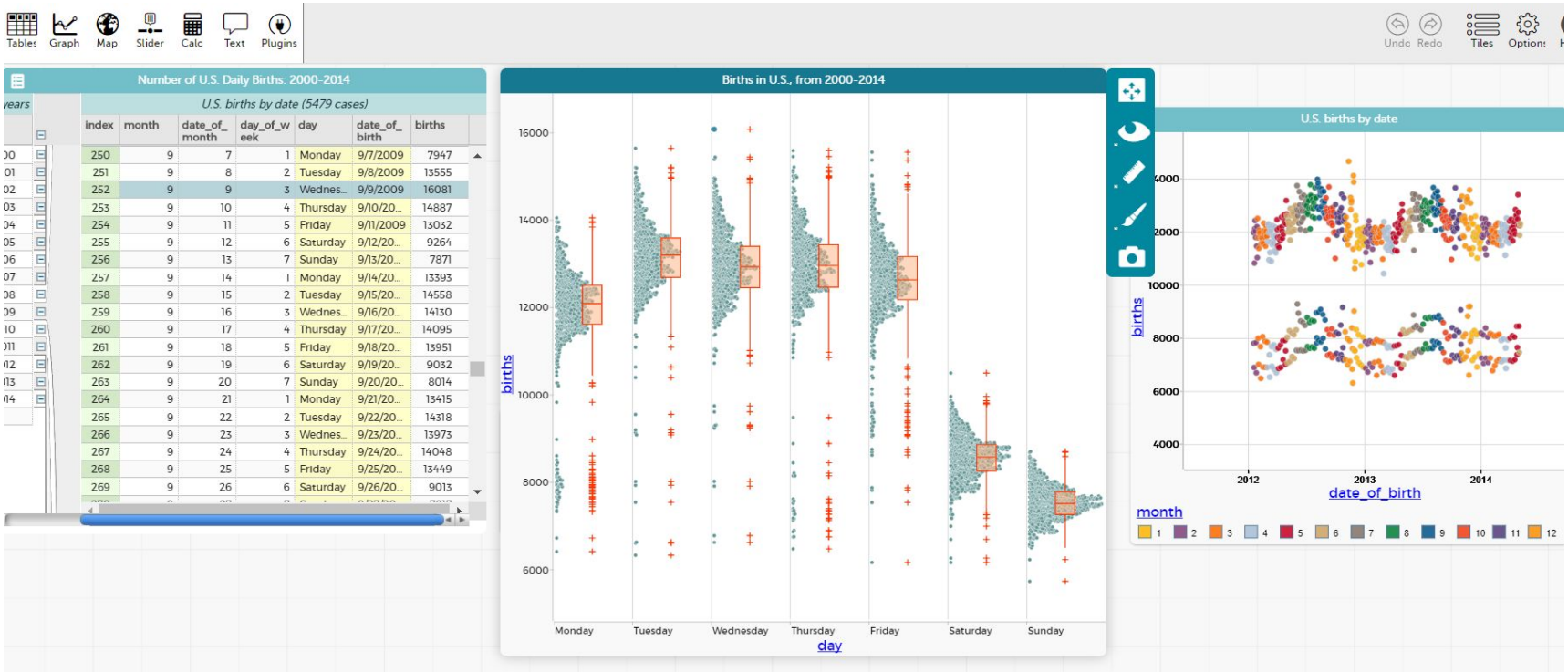
Questions about births per day

Are birthdays uniformly distributed throughout the year?

Is every birthday just as likely as any other birthday?

In the US, are there about the same number of births recorded on every day throughout the year?

bit.ly/2C3MJQU



Scheduling Births--A Convenience Event?

- Read articles related to births in the US (E.g., "time to have a baby"
- Have students write a report about their findings from the data investigation and compare with other sources.
- What do they wonder? Is the pattern from 2000-2014 the same if we look at births from 1950-1964? What if we examine births in other countries? How would source that data? What variables would you want in the data set?

Goal: Increase opportunities for learning data science and statistics.....

within existing curricula with easy to use tools!

Core Design Principles for Data, Tools, and Tasks

- Data is real (collected by students or authenticated by teacher), multivariate (categorical & quantitative), “large”, and sometimes messy
- Data contexts are engaging to students

- Tools facilitate data moves, in tabular and graphical form
- Tools support links among representations of data

- Tasks have multiple entry points for different levels of sophistication
- Tasks provoke curiosity and promote different ways of engaging with data

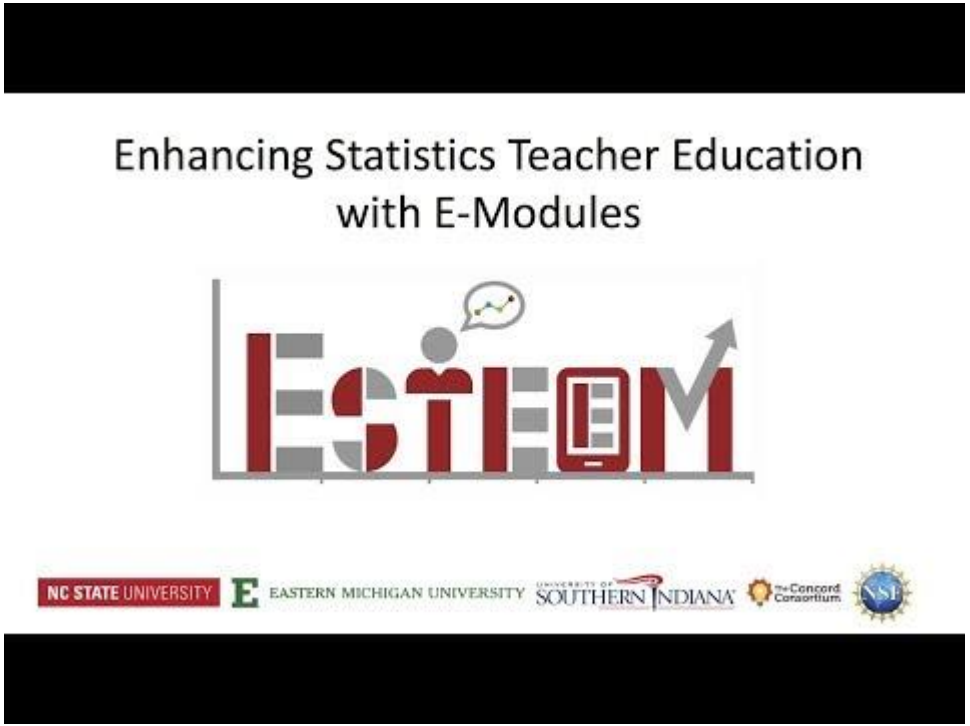
Let's dive into an example of how to engage students in real data

Context: Roller coasters

Wooden

Steel

Launching a Data Investigation



https://youtu.be/aXolxokHRxU

Open Roller Coaster Data

Codap.concord.org

Click on **Try Codap** (upper right)

Choose “Open Document or Browse Examples”

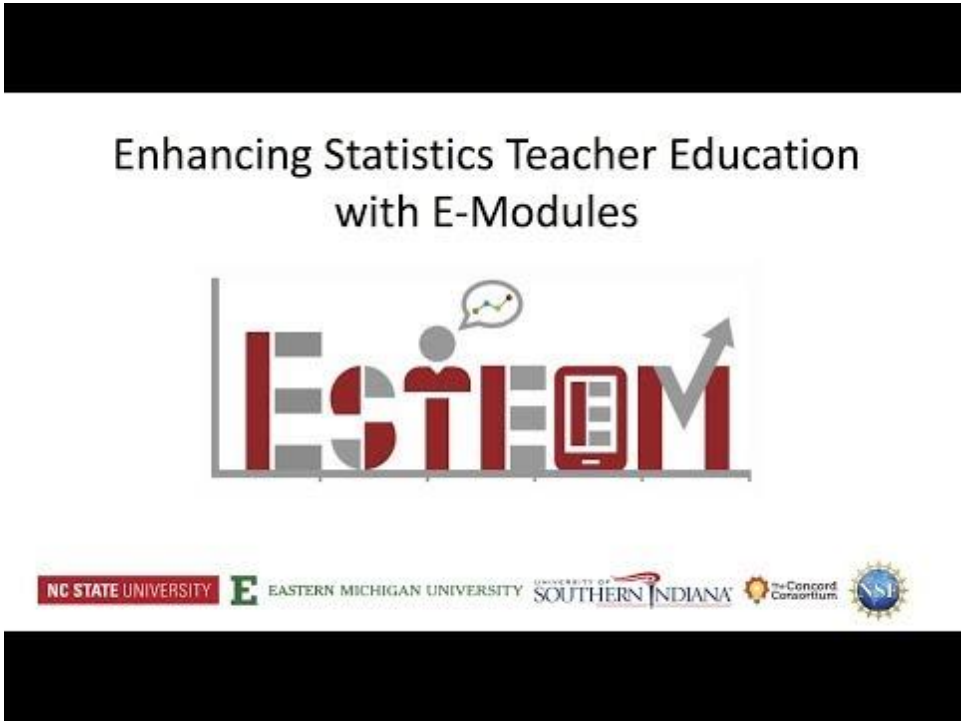
Choose Roller Coasters

Questions to Consider

- What do you notice about the top speed of these coasters? What factors may be related to the speed of a coaster?
- Do wooden coasters tend to have the same height as coasters made from steel? How do the wooden and steel coasters differ with other variables? Does anything surprise you?
- Are roller coasters that have inversions taller than roller coasters without inversions? Why or why not?

What standards can be addressed with such an investigation?

What do students do with real data?



Great Resources for Teaching Statistics

https://www.nytimes.com/column/whats-going-on-in-this-graph

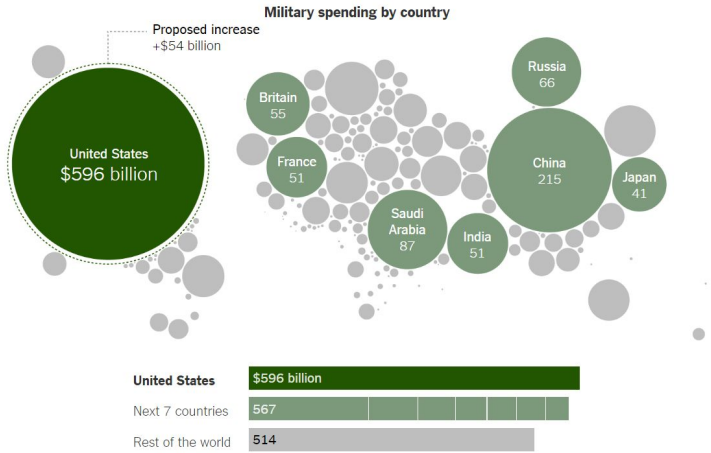
Week of Feb 13: This graph shows the relative size of military budgets by country in 2015. It originally appeared elsewhere on NYTimes.com.
After looking closely at the graph above, think about these three questions:

- **What do you notice?**
- **What do you wonder?**

What are you curious about that comes from what you notice in the graph?

- **What might be going on in this graph?**

Write a catchy headline that captures the graph's main idea. If your headline makes a claim, tell us what you noticed that supports your claim.



http://statisticsteacher.org

ASA NCTM
STATISTICS TEACHER
SUPPORTING THE TEACHING AND LEARNING OF STATISTICS

A few videos to ponder:

"How To" videos in CODAP

- Basics of CODAP
- Using Sampler

Interviews with Teachers

- Advice for teaching stats in the math curriculum
- Two teachers talk about tools and resources for Stats

CODAP and Data Investigations in the Classroom-Teacher and students in action!

- 7th graders working with roller coasters and sharing work
- AP Stats students examine linear models with vehicle data

Ready to Learn More?

http://go.ncsu.edu/tsir

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