

Exemplar of Data-Empowered Teaching and Learning

Hollylynn S. Lee

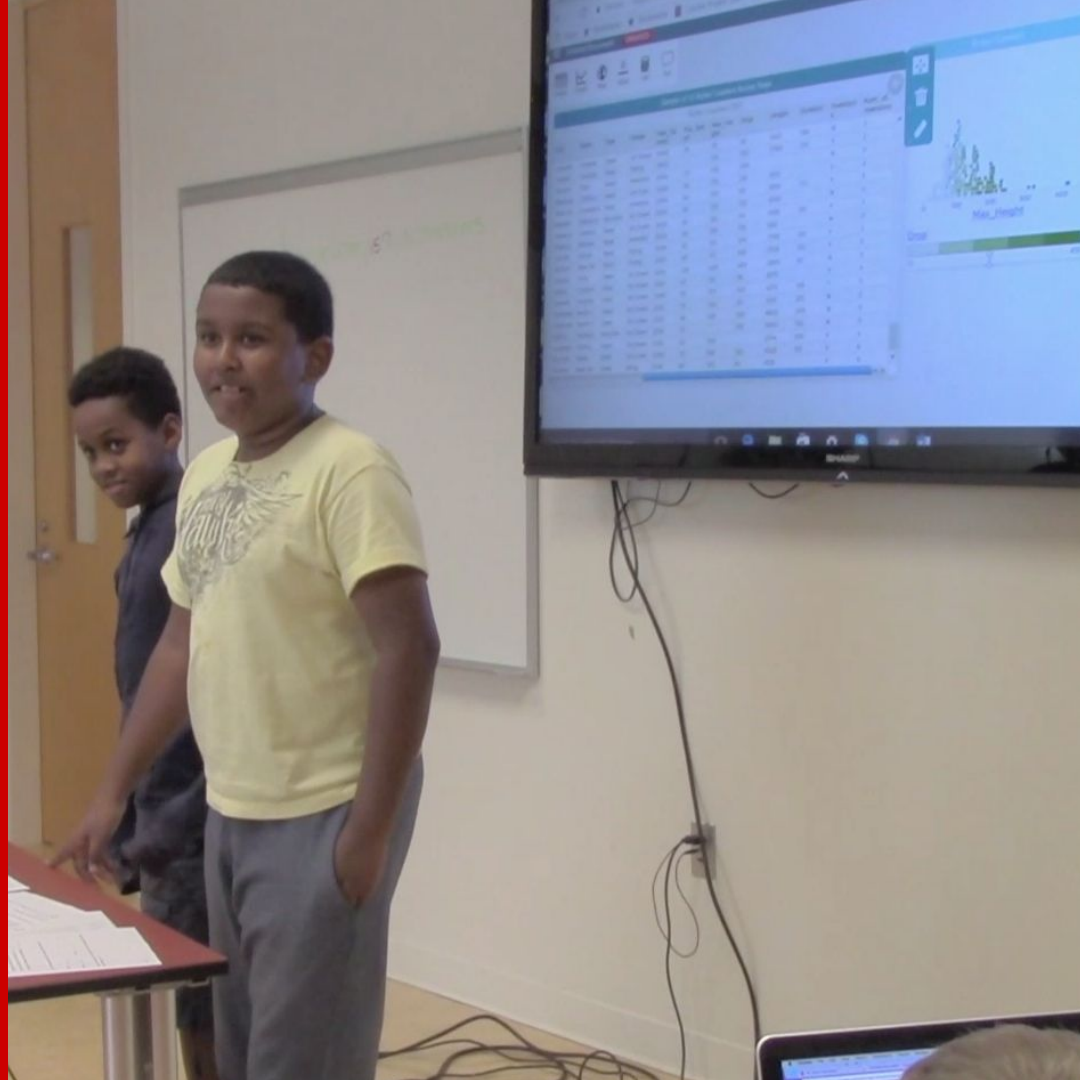
September 28, 2023

NC Data Science Education
Summit

NC STATE UNIVERSITY

College of Education

Friday Institute for Educational Innovation



Director:
Hollylynne
Lee



HI-RiSE: A Hub for Innovation and Research in Statistics Education

Building Foundations for Future Data Scientists

Co-Director:
Gemma
Mojica

**Building foundations for data scientists and data-informed
citizenry**



Data
WRITING
Stories

fi.ncsu.edu/teams/hi-rise/



Coming Soon

Amplifying Statistics and Data
Science in Classrooms



Teaching Statistics Through
Inferential Reasoning



Teaching Statistics Through Data
Investigations

 InSTEP

Invigorating Statistics and Data Science
Teaching through Professional Learning

DICE

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Acknowledgments



Materials used in this presentation were partially funded by the 2018-19 University Scholars program through RTI International and the National Science Foundation under Grant No. DRL **1908760**, **1900606** and DUE **1625713** and **2141727** awarded to NC State University. Any opinions, findings, and conclusions or recommendations expressed herein are those of the presenters and do not necessarily reflect the views of the NSF or RTI.

Work of Data Scientists: An Ethnographic Study

Immersed in workplace for 9 months:

- observations of group meetings, presentations, informal conversations
- interviews with 5
- interviews posted on public sites



Key Practices, Processes and Dispositions of Data Scientist

**Role of Context/
Purpose of Problem**

**Flexibility/
Skepticism**

**Communication and
Visualization**

Immersed in Data

**Team work and
seeking expertise**

Broad Toolkit

Persistent/Resilient

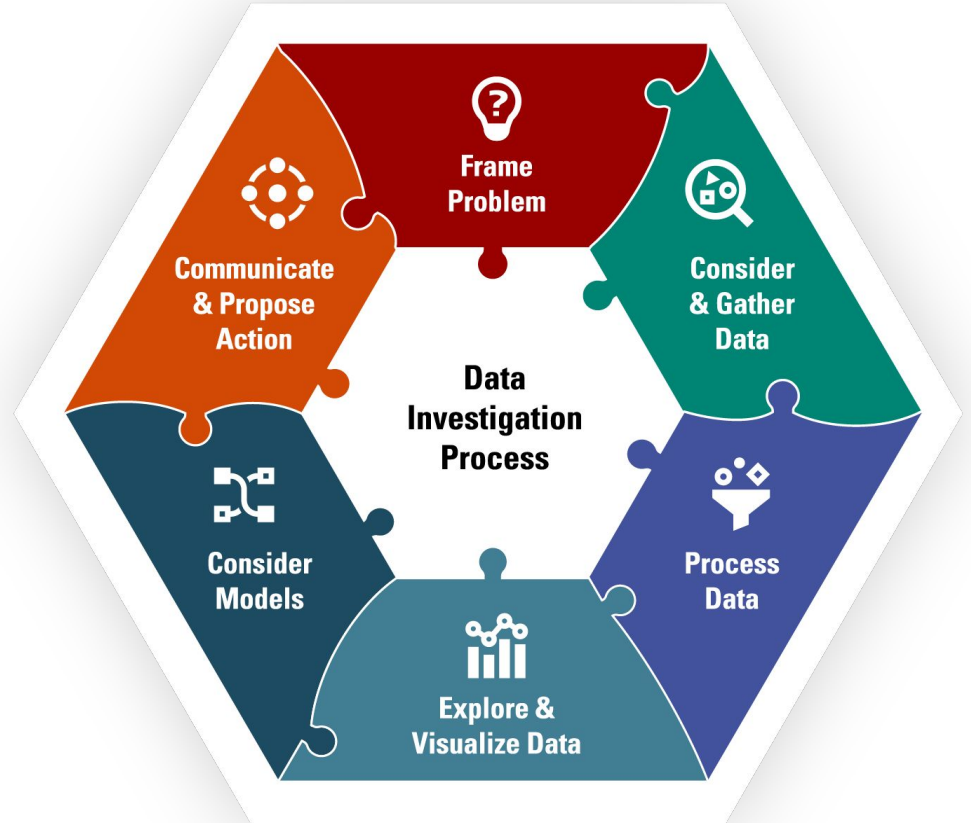
Data Investigation Process

More holistic, nonlinear, and reflective of data science practices

Lee, Mojica, Thrasher, & Baumgartner, 2022

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Communicate & Propose Action

- Craft a data story to convey insight to stakeholder audiences.
- Justify claims with evidence from data and propose possible action.
- Address uncertainty, constraints, and potential bias in the analysis.



Consider Models

- Analyze and identify models that address the problem.
- Consider assumptions and purpose of the models.
- Recognize possible limitations.



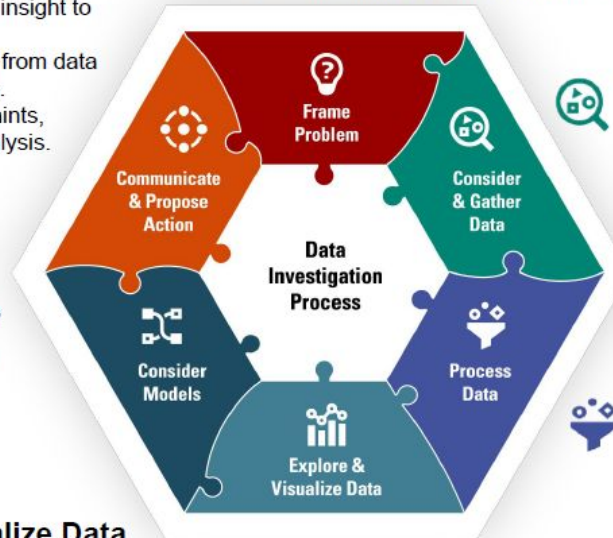
Explore & Visualize Data

- Construct meaningful visualizations, static or dynamic.
- Compute meaningful statistical measures.
- Explore and analyze data for potential relationships or patterns that address the problem.



Frame Problem

- Consider real-world phenomena & broader issues related to problem.
- Pose investigative question(s).
- Anticipate potential data and strategies.



Consider & Gather Data

- Understand possible attributes, measurements, and data collection methods needed for the problem.
- Evaluate and use appropriate design and techniques to collect or source data.
- Consider sample size, access, storage, and trustworthiness of data.



Process Data

- Organize, structure, clean, merge, and transform data in efficient and useful ways.
- Consider additional data cases or attributes.

Key Considerations & Dispositions

Make sense of data with respect to context

Take advantage of technology

Attend to variability & uncertainty

Seek expertise & information

Communicate & collaborate

Be curious creative, & intuitive

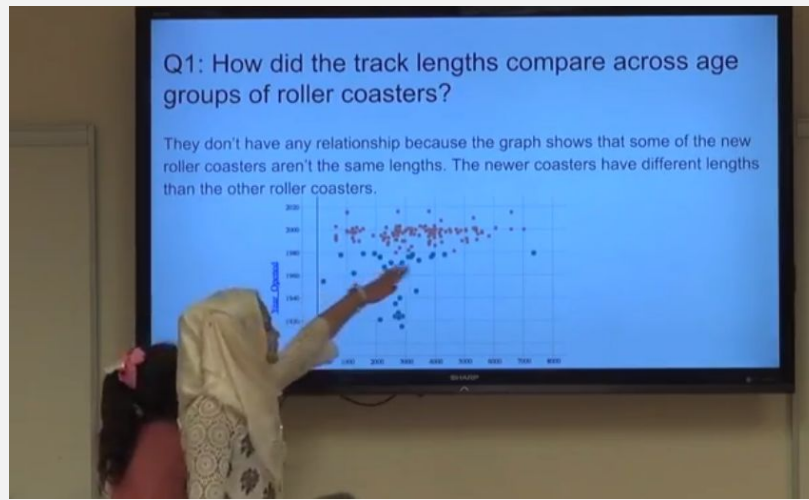
Persist & be resilient

Consider ethical issues & biases

Be a skeptic

Big(ger) Data

(multivariate with different types of attributes, messy, many cases)



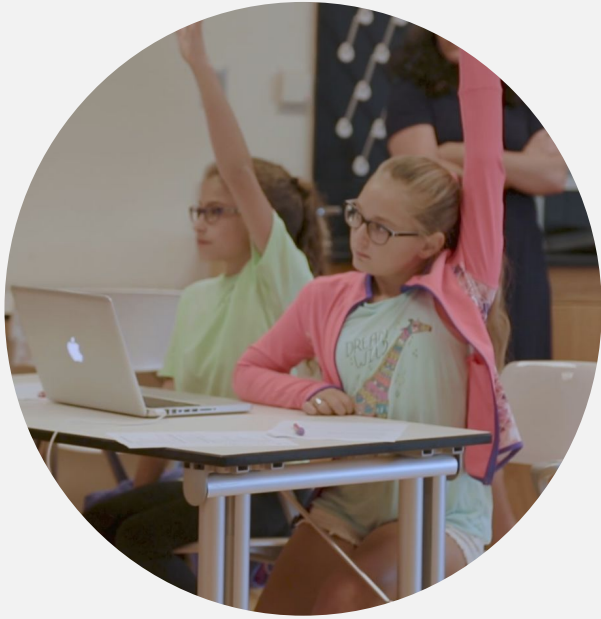
Use of visualization and analysis tools that link representations and facilitate data moves and simple coding

Data Intensive Approach



Engage with real contexts





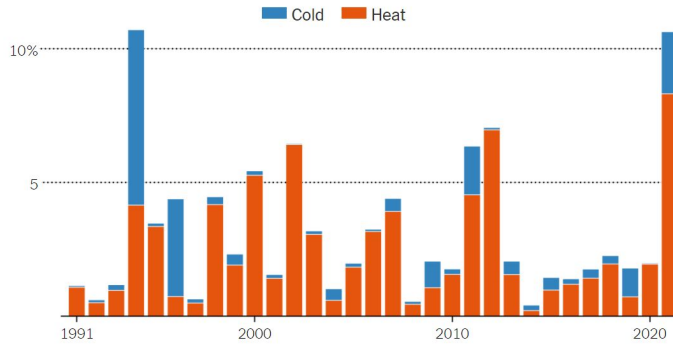
Every Subject Matter

All learners

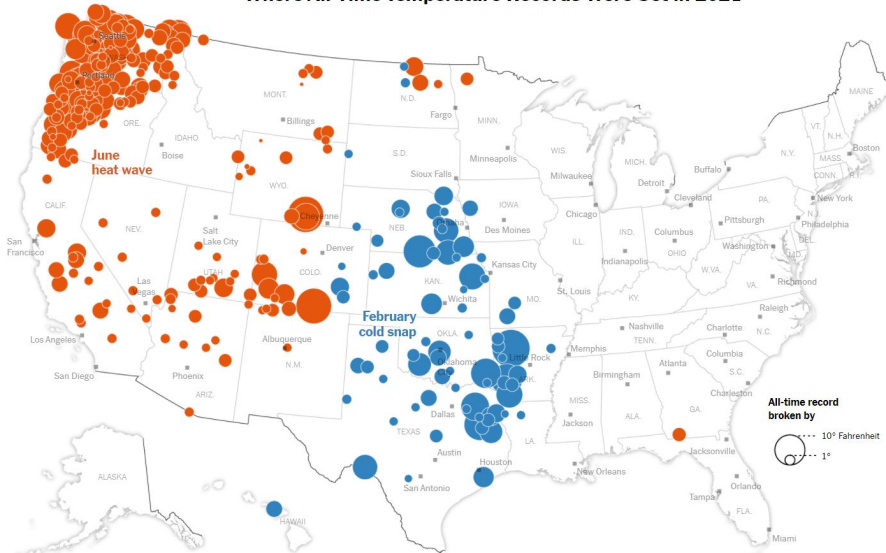
Aspects of Data
Science should be
Everywhere and for
Everyone

Percentage of U.S. Weather Stations That Broke All-Time Temperature Records

All-time temperature records were set in 2021 at 10.6 percent of all U.S. stations.



Where All-Time Temperature Records Were Set in 2021



Source: Global Historical Climatology Network of the National Oceanic Atmospheric Administration (NOAA); Note: The number of active weather stations varies by year.

Data in the News

What do you notice?

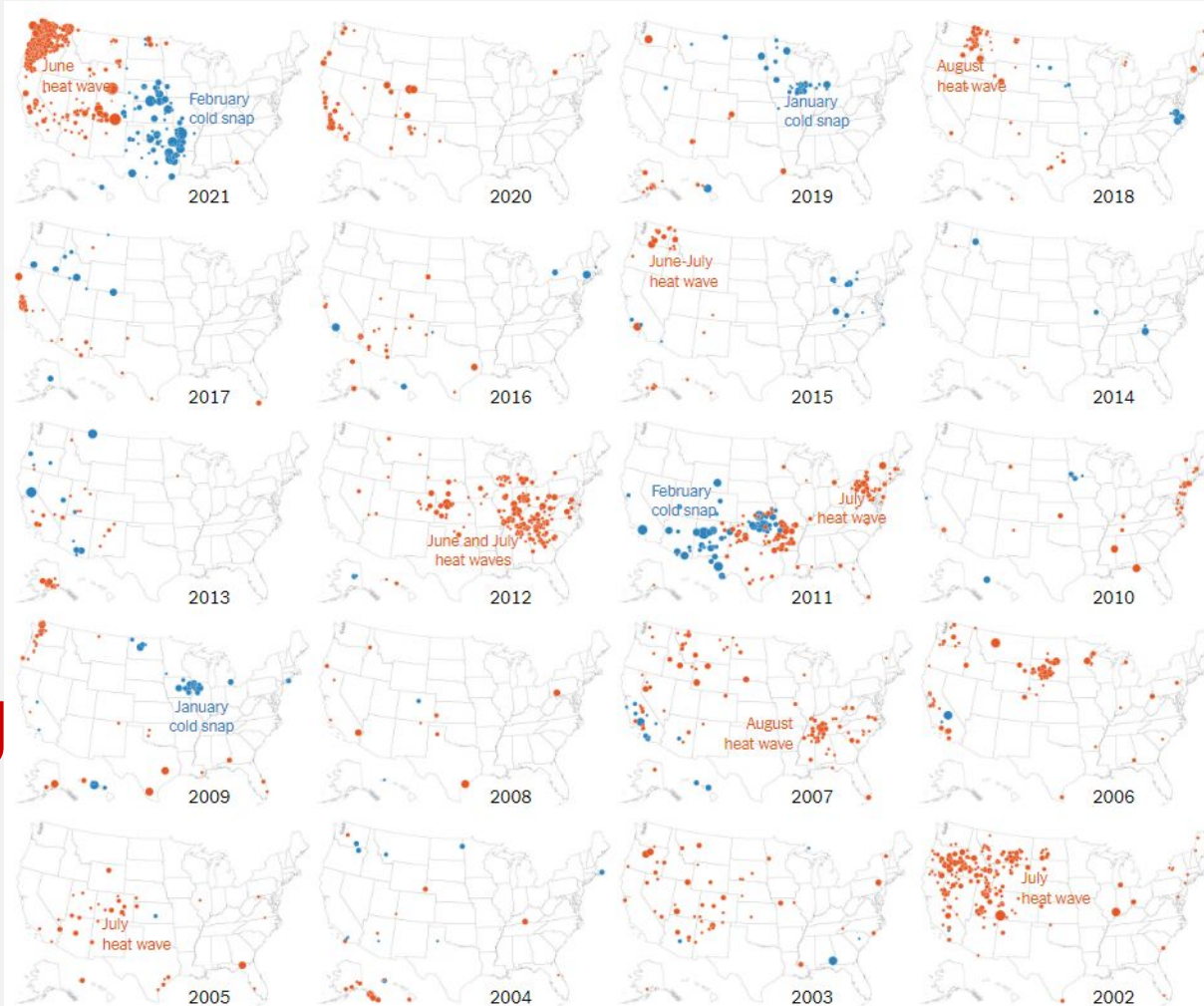
What do you wonder?

<https://www.nytimes.com/2022/03/10/learning/whats-going-on-in-this-graph-march-16-2022.html>

Original Article: *A Vivid View of Extreme Weather: Temperature Records in the U.S. in 2021*

By Krishna Karra and Tim Wallace, Jan. 11, 2022

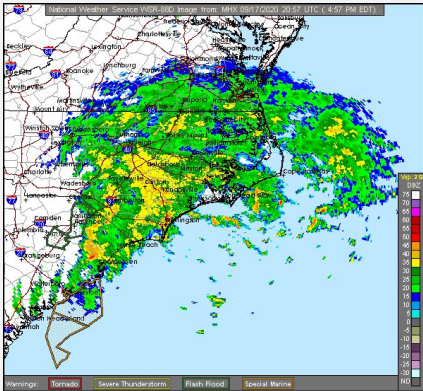
**20
years
of
record
setting**



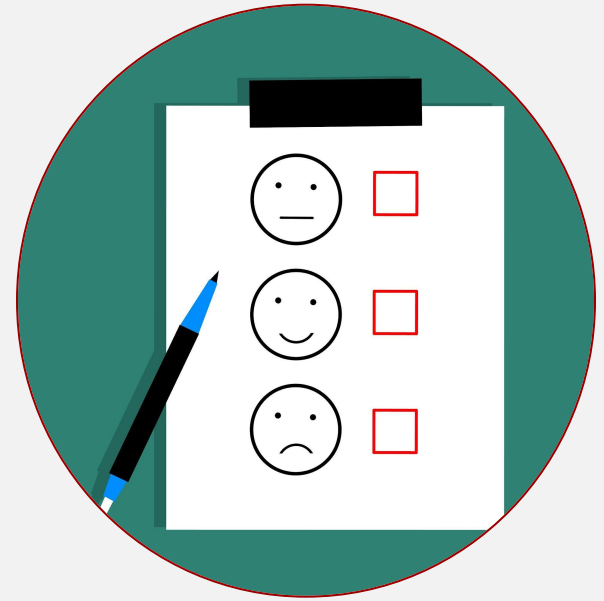
**What
about
NC?**



Let's Think About Weather in Raleigh Durham Area



YES, you may use
your device!



Time for a Poll

Our Poll Results

BEST GUESS: What was the lowest minimum daily temperature in RDU in past 20 years?



BEST GUESS: What was the highest maximum daily temperature in RDU in past 20 years?



In the month of September for the past 20 years, what do you think is a typical difference between daily high and low temperatures (degrees F)?

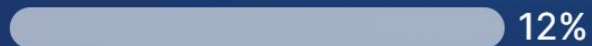
19-22



22-25



13-16



25-28



28-31



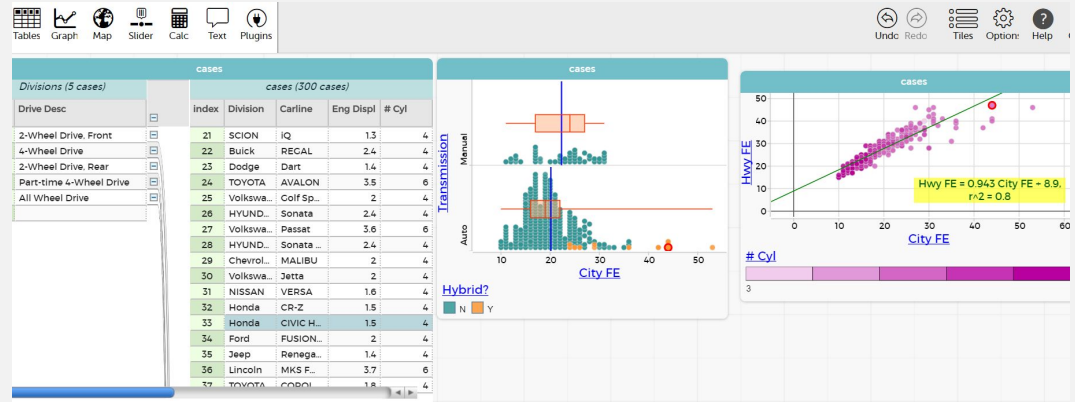
31-34

codap.concord.org

Free
Web-based
No login required
Easy to use
Under continual development

Works best in Chrome or FireFox

Optimal on computer or chromebook or large tablet



Includes "Plugins" that expand capability. TWO of these are data portals connected to NOAA and US Census!

Let's Collect Weather Data

codap.concord.org/app

Used the Plugin NOAA Weather to collect 20 years of daily measurements from RDU weather station

v0013 NOAA Weather

Retrieve weather data from observing stations.

Date Range monthly daily hourly

09/25/2003 to 09/25/2023

Units: Metric Standard

Station Location RALEIGH-DURHAM INTERNATIONAL AP (1944-06-01 - present)

Find a weather station

Attributes 6 tMax, tMin, tAvg, precip, snow, avgWind

Choose attributes to include in your data set from the list below.

<input type="checkbox"/>	Attributes	Abbr.	Units
<input checked="" type="checkbox"/>	Maximum temperature	tMax	°F
<input checked="" type="checkbox"/>	Minimum temperature	tMin	°F
<input checked="" type="checkbox"/>	Average temperature	tAvg	°F
<input checked="" type="checkbox"/>	Precipitation	precip	in
<input checked="" type="checkbox"/>	Snowfall	snow	in
<input checked="" type="checkbox"/>	Average windspeed	avgWind	mph

Retrieved 7304 cases

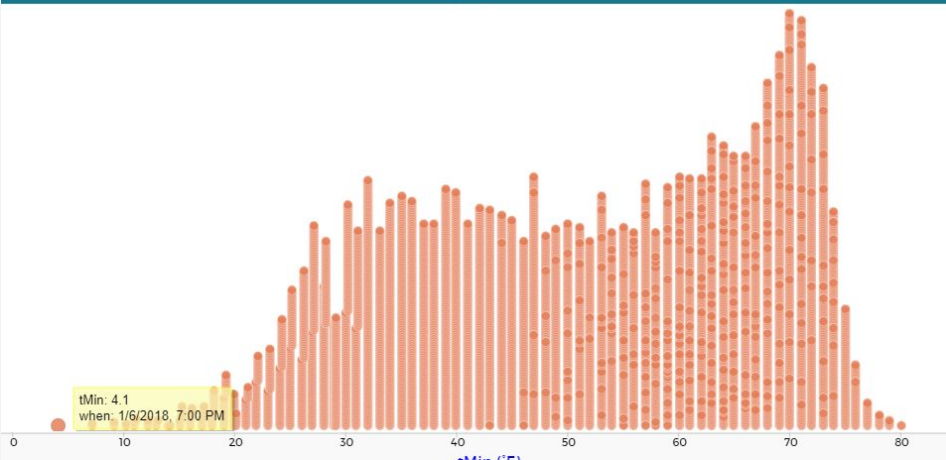
NOAA-Weather

NOAA-Weather (1 cases)								Observations (7304 cases)							
In-dex	where	latitude (°)	longi-tude (°)	UTC off-...t (hours)	timezone	elevation (ft)	report type	In-dex	when	tMax (°F)	tMin (°F)	tAvg (°F)	precip (in)	snow (in)	avgWind (mph)
1	RALEIG...	35.89	-78.78	-5	EST	416	daily	1	9/25/2003,	82.04	55.04	69.08	0	0	2.68
2								2	9/26/2003,	82.94	57.92	71.06	0	0	3.13
3								3	9/27/2003,	82.94	57.02	69.98	0	0	2.68
4								4	9/28/2003,	78.08	59	69.08	0	0	4.7
5								5	9/29/2003,	68	46.04	57.02	0	0	4.7
6								6	9/30/2003,	69.98	42.98	57.02	0	0	2.01
7								7	10/1/2003,	71.06	44.06	57.92	0	0	2.91
8								8	10/2/2003,	66.02	42.98	55.04	0	0	6.26
9								9	10/3/2003,	64.94	35.96	51.08	0	0	2.68
10								10	10/4/2003,	75.02	48.02	62.06	0	0	6.04
11								11	10/5/2003,	75.04	48.92	60.98	0	0	2.01
12								12	10/6/2003,	75.92	48.02	62.06	0	0	2.68
13								13	10/7/2003,	77	57.02	66.92	0	0	2.46
14								14	10/8/2003,	66.92	57.02	62.06	0.36	0	5.14
15								15	10/9/2003,	75.92	62.96	69.98	0.11	0	6.71
16								16	10/10/2003,	64.94	60.08	62.96	0.22	0	8.5
17								17	10/11/2003,	66.02	60.98	64.04	0.02	0	6.04
18								18	10/12/2003,	80.06	59	69.98	0	0	2.01
19								19	10/13/2003,	78.08	55.94	66.92	0	0	3.13
20								20	10/14/2003,	69.08	55.04	62.06	0.48	0	8.05
21								21	10/15/2003,	69.08	42.98	55.94	0	0	6.49
22								22	10/16/2003,	71.96	39.92	55.94	0	0	3.13
23								23	10/17/2003,	75.02	44.96	60.08	0.01	0	5.82
24								24	10/18/2003,	64.04	42.08	53.06	0	0	6.26

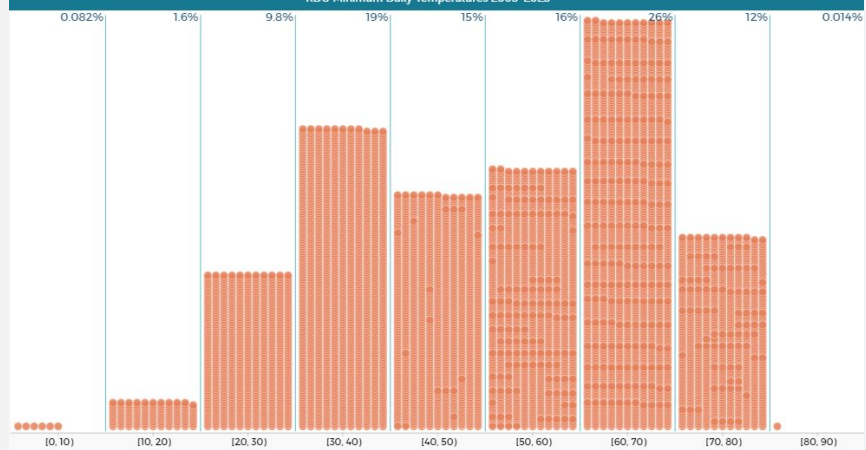
US-Weather-Stations

isActive
 false true

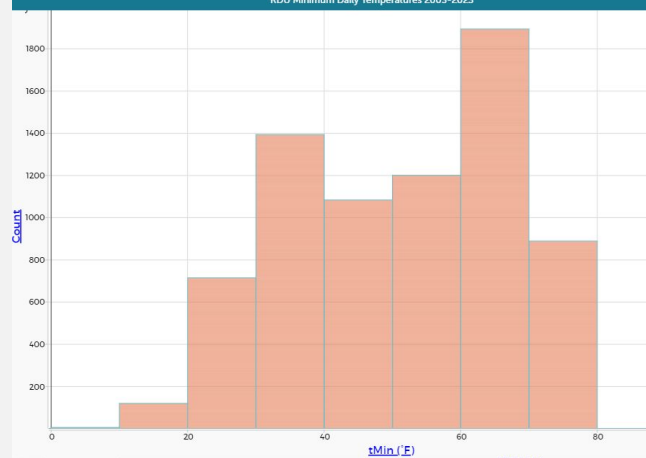
RDU Minimum Daily Temperatures 2003-2023



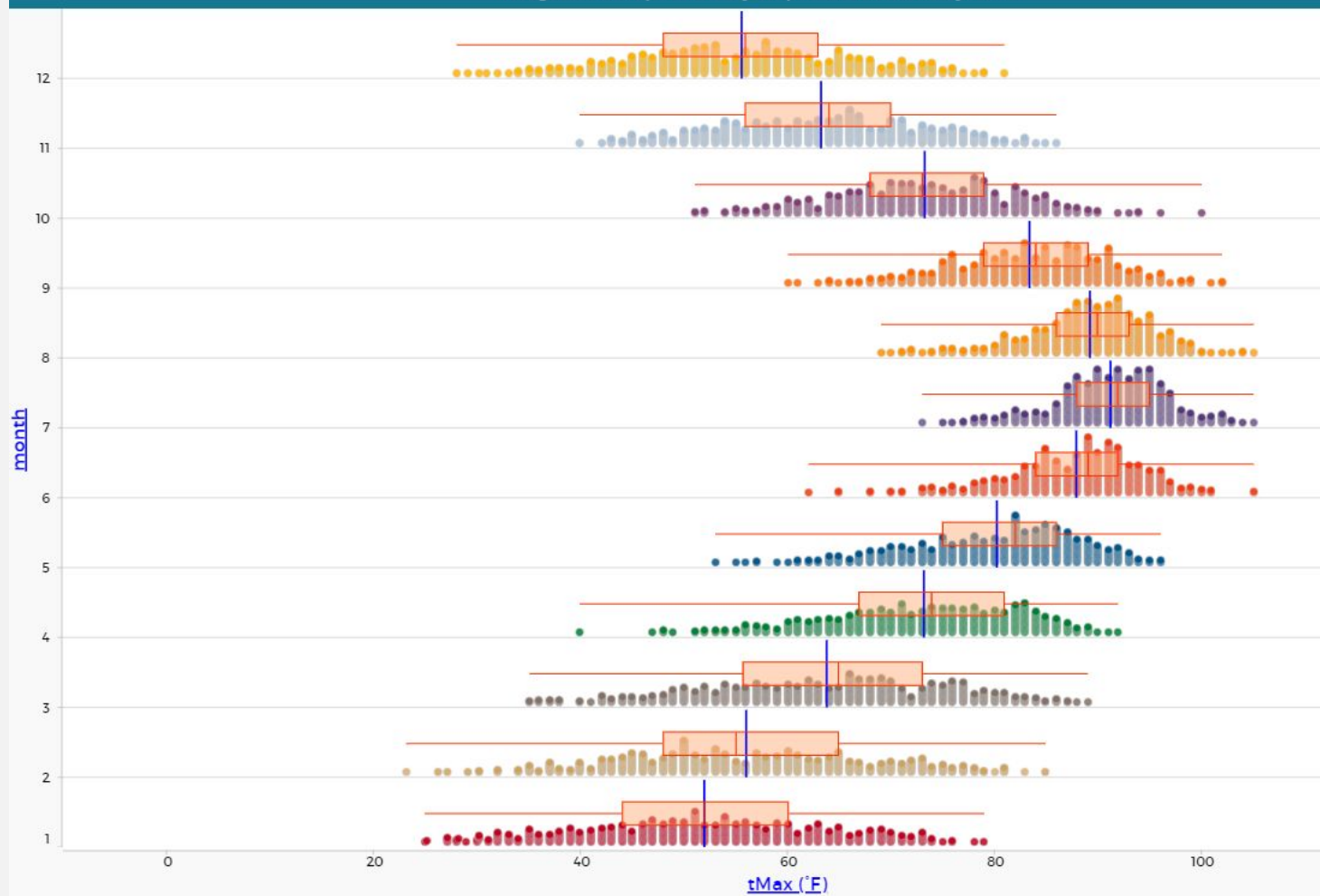
RDU Minimum Daily Temperatures 2003-2023



RDU Minimum Daily Temperatures 2003-2023



Raleigh Durham Airport Max Daily Temperatures 2003-2023 by Month

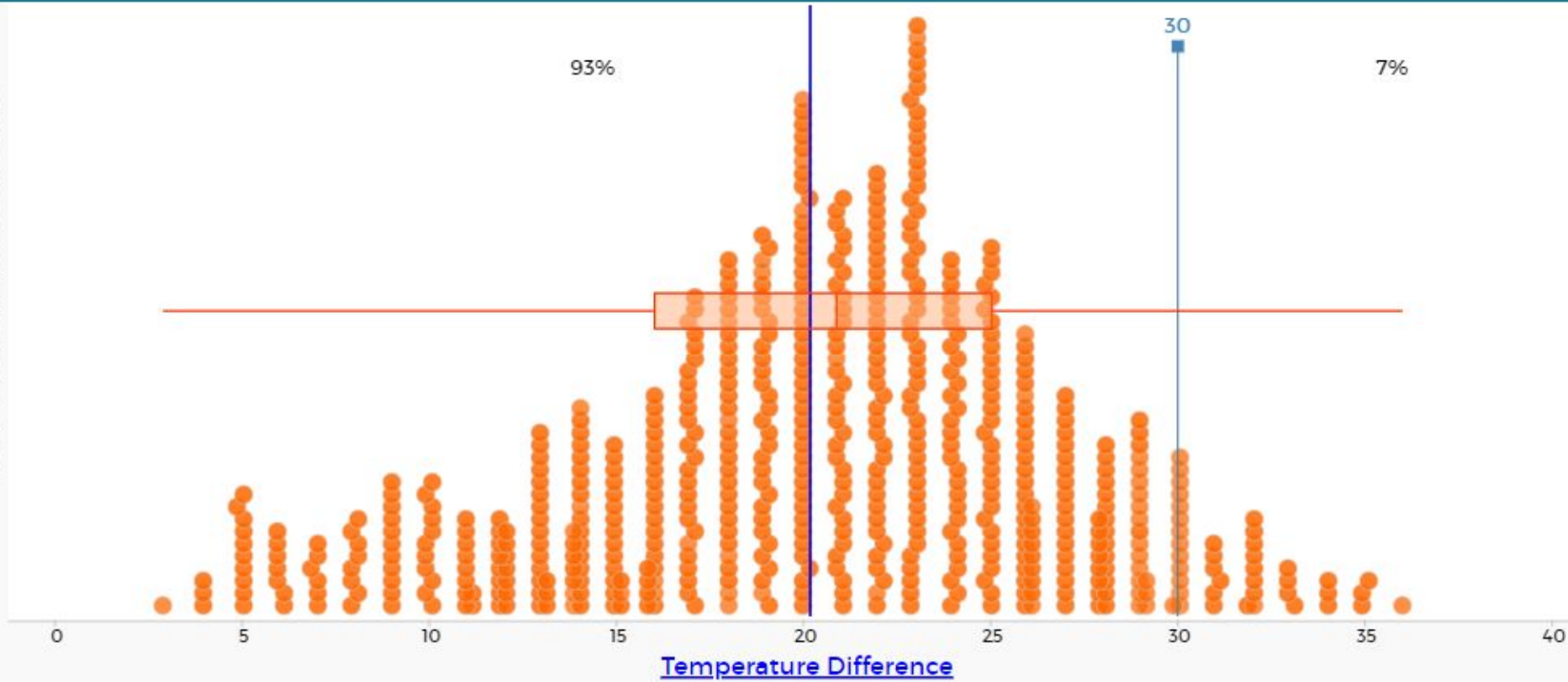


month



RDU Airport Daily Temperature Swing in September 2003-2023

[Click here, or drag an attribute here.](#)



[month](#)

9

Support for Teachers' Professional Learning

Personalized Learning for Teaching Statistics and Data Science in Grades 6-12

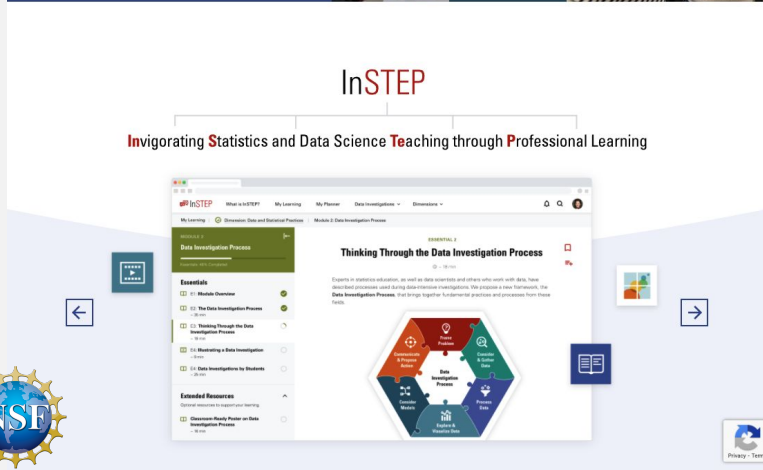


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InSTEP

Develop teacher expertise in K-12 statistics and data science teaching through free, personalized professional learning.

Notify me when InSTEP is available →



InSTEP
Invigorating Statistics and Data Science Teaching through Professional Learning

Thinking Through the Data Investigation Process

Experts in statistics education, as well as data scientists and others who work with data, have identified practices used during data-investigation. This process is our framework, the **Data Investigation Process**, that brings together fundamental practices and processes from these fields.

Essentials

- 01 Module Overview
- 02 The Data Investigation Process
- 03 Thinking Through the Data Investigation Process
- 04 Assessing a Data Investigation
- 05 Data Investigations for Students

Extended Resources

- 06 Openness Ready Poster on Data Investigation Process

Privacy - Terms



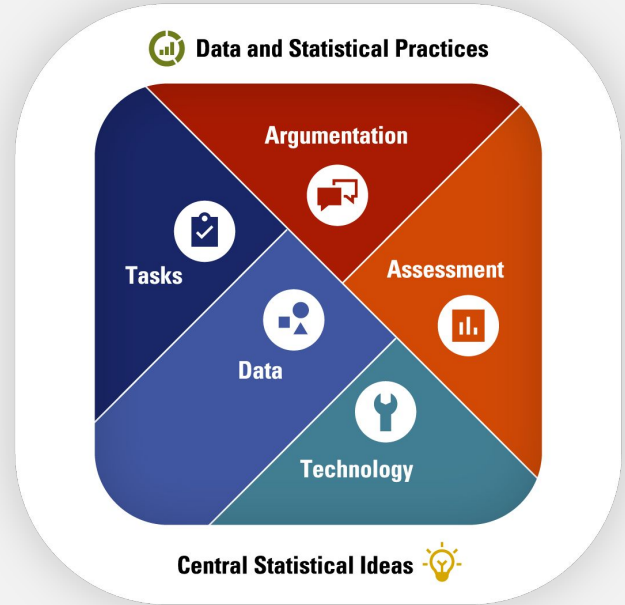
InSTEP

instepwithdata.org

FREE for All!



InSTEP is organized by anchoring professional learning in **Seven Dimensions of Teaching Statistics and Data Science** which describe important aspects that support teaching and learning environments for statistics and data science.



**Effective Learning
Environments for
Statistics and Data
Science**

Two Primary Pathways: Data Investigations & Self-Paced Modules

Use Variety of
Tech Tools, but
primarily CODAP

The screenshot displays the InSTEP Learning Hub interface. At the top, there is a navigation bar with the InSTEP logo, 'Learning Hub', and several menu items: 'Dashboard', 'Data Investigations', 'Dimensions', and 'Microcredentials'. On the right side of the navigation bar are links for 'FAQ', 'About InSTEP', a notification bell, and a user profile icon.

The main content area is divided into two primary sections:

- Data Investigations**
In-depth Learning Experiences
Start here to dive into a data investigation to experience working with "big data" and envision what may be possible in your classroom.
- Dimensions of Teaching Statistics and Data Science**
Self-paced Modules
Pursue your own professional learning pathway by choosing a module in a specific area of teaching statistics and data science that interests you.

Under the 'Data Investigations' section, there are two featured cards:

- DATA INVESTIGATION 1: US Roller Coasters**
Engage in a data investigation to compare, contrast and examine trends in US roller coasters using a technology tool, CODAP. 100% Completed.
- DATA INVESTIGATION 2: Census at School**
In this data investigation you have an opportunity to feel awash in a bigger, messy dataset through sampling student-generated data from the Census at School Project. 50% Completed.

Under the 'Self-paced Modules' section, there are four module cards:

- Data and Statistical Practices**
Explore foundational processes, practices, and ways of thinking used in statistics and data science. 2 Modules | 27% Completed.
- Central Statistical Ideas**
Develop deeper understanding of key statistical and data content taught in K-12 curriculum. 2 Modules | Not Started.
- Tasks**
- Data**

At the bottom left, there is a circular graphic showing a progress indicator for 'Data and Statistical Practices' with a sub-section for 'Argumentation'.

Two Open Access Papers to Learn More About Data Investigations

**Digging into Data:
Illustrating a Data
Investigation Process**

2022

Statistics Teacher

[statisticsteacher.org/2022/
03/23/diggingdata/](https://www.statisticsteacher.org/2022/03/23/diggingdata/)

**Investigating Data like a
Data Scientist: Key
Practices and Processes**

2022

*Statistics Education
Research Journal*

[iase-web.org/ojs/SERJ/arti
cle/view/41](https://www.iase-web.org/ojs/SERJ/article/view/41)

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Sample Research to Support Examples

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- Rubel, L. H., Nicol, C., & Chronaki, A. (2021). A critical mathematics perspective on reading data visualizations: reimagining through reformatting, reframing, and renarrating. *Educational Studies in Mathematics*, 108(1-2), 249-268.
- Shapiro, B. W., Meng, A., Rothschild, A., Gilliam, S., Garrett, C., DiSalvo, C., & DiSalvo, B. (2022). "Bettering Data": The Role of Everyday Language and Visualization in Critical Novice Data Work. *Educational Technology & Society*, 25(4), 109-125. <https://www.jstor.org/stable/48695985>
- Wilkerson, M. H., Lanouette, K. A., & Shareff, R. L. (2021). Exploring variability during data preparation: A way to connect data, chance, and context when working with complex public datasets. *Mathematical Thinking and Learning*. doi: 10.1080/10986065.2021.1922838