

Learning Data Science in K-12 Education

Data Science 4 Everyone
The University of Chicago
Summer 2023

Critical Mission:

**Catalyze the adoption of
data science & data literacy
as an integrated component
of K-12 education
by 2030.**



National Progress

Overview & Movement Strategy

Summer 2023

0 1	0 0 00	0 1 11 01	0 0
0 0 1	0 0 1 0	0 1 0 01 10	1 11 1
1 0	0 00 00	1 1 1 0	0 1 0
11 0 00	1 1 0 0	0 0 0	0 00
00 0 1 0 1 1 1	1 0 0 1 1 1 0	1 0 1 0 0	0 0 0 0 0
11 0 0 1	1 1 00 0 0 1 0	1 0 0 0 1 0 01 10	1 0 1 11 1
1 0	0 00 00	1 1 1 0	0 1 0
11 0 00	1 1 0 0	0 0 0	0 00
00 0 1 0 1	1 0 0 1 1 1 0	1 0 1 0 0	0 0 0 0 0
11 0 0 1	1 1 00 0 0 1 0	1 0 0 0 1 0 01 10	1 0 1 11 1
1 0	0 00 00	1 1 1 0	0 1 0
11 0 00	1 1 0 0	0 0 0	0 00
00 0 1 0 1	1 0 0 1 1 1 0	1 0 1 0 0	0 0 0 0 0

Why focus on data?

- **Improve personal financial, health, and civic decision-making in the data deluge of our modern information economy**
- **Mitigate the digital divide and create confident users of emerging technologies (AI, blockchain, etc.) at a population level**
- **Mitigate workforce automation effects as tasks become increasingly computer-assisted with data inputs and outputs¹**

1: ([McKinsey, 2019](#)) projects higher rates of displacement for Black American workers

Why integrate in K-12?

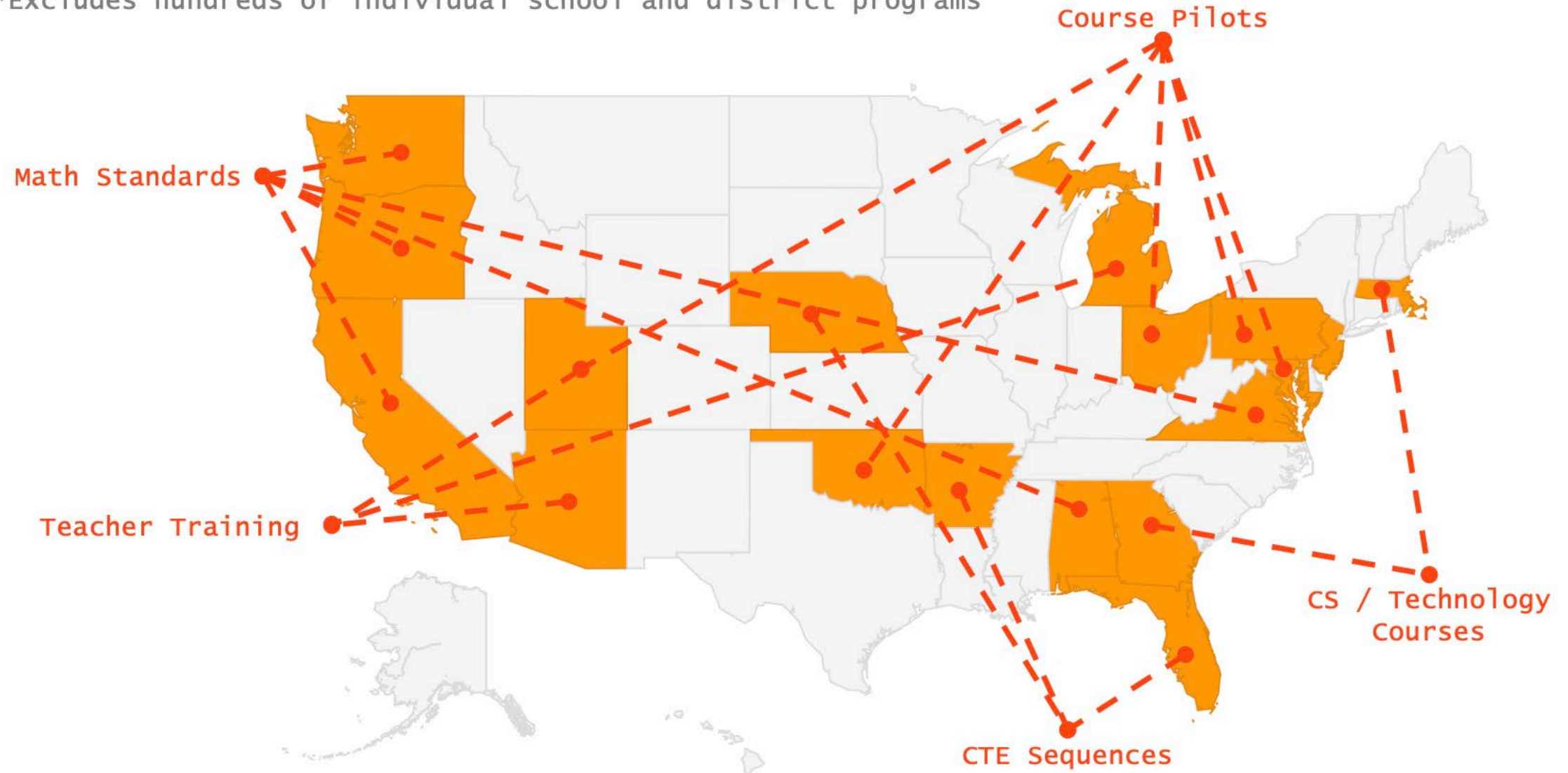
- **Fix K-12 math education challenged by low student motivation and high school graduation barriers.**
- **Prepare for today's college degrees where 138 college disciplines now require data analytics as fields adopt computational tools²**
- **Modernize alternative vocational routes with early exposure to low-cost digital training, credentials, and apprenticeships straight from high school**

2: American Statistical Association (ASA), 2017.

K-12 Data Science is growing:

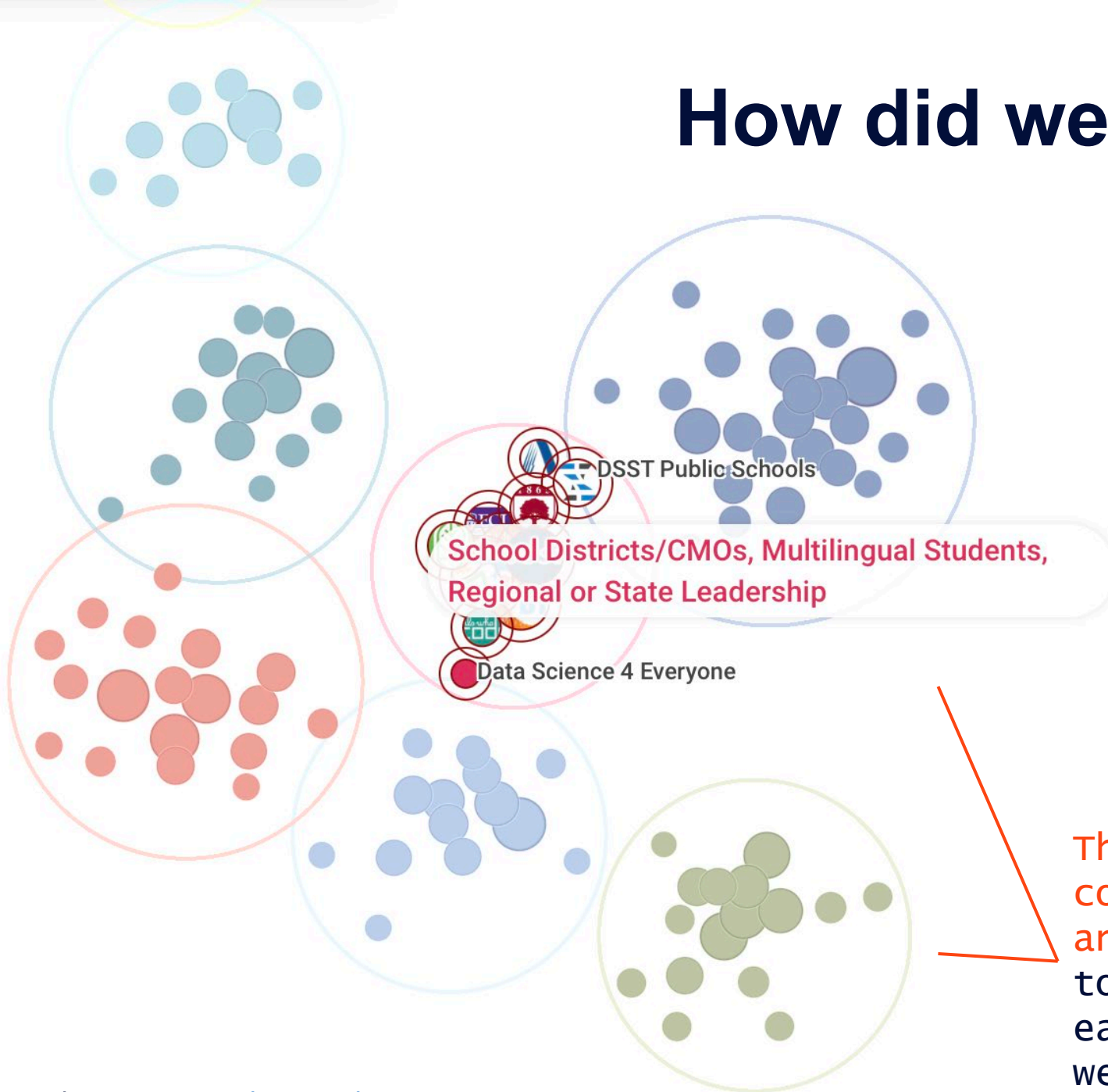
State-wide data science education programs (2023-2024)

*Excludes hundreds of individual school and district programs



How did we do it? **Field-building.**

**System coordination.
Centralizing information.
Technical assistance.
Talent-placement.
Policy support.
Case-making.
Gap-filling.**



The K-12 system is complex, decentralized, and over-burdened. We try to help connect people to each other and share what we've learned.

Where we are:

6.1% of schools offer

data science coursework (out of 26,000 U.S. high schools) – estimated as of 2022-23 school year

3.6% of students have enrolled

in data science coursework (out of 15.1 million high school students, with 3.75 million per grade)

0.9% of teachers have been trained

in basic data science pedagogy and software tools (out of 246,000 high school math teachers)

Where we need to go:

All schools offer, especially rural and majority-poverty (Title I)

All students participate K through 12, via integrated coursework in existing school subjects that everyone takes.

All relevant teachers trained, with a focus on mathematics, social studies, and science subjects.

K-12 data science is “new,” but with a history:

2013 – NSF grants fund curriculum, software research

2017 – Data Science Education Technology Conference (Concord Consortium)

2019 – IDSSP Framework Released

DS4E is created @ UChicago RISC

2020 – GAISE II Framework Released

2020 – National K-12 Summit at Stanford University

2021 – K-12 Technical Working Group (IES)

2022 – Foundations of Data Science Workshop (National Academies Workshop)

The screenshot shows the National Academies website. The header includes the logo for the National Academies of Sciences, Engineering, and Medicine, and a navigation menu with links: About Us, Events, Our Work, Publications, Topics, Engagement, and Opportunities. A search bar is located in the top right corner. The main heading of the page is "Foundations of Data Science for Students in Grades K-12: A Workshop". Below the heading is a "SHARE" button with icons for Facebook, Twitter, LinkedIn, and Email. A sidebar on the left contains a list of links: About, Description, Committee, Sponsors, Past Events, and Contact. The main content area features a paragraph about the importance of data science in the K-12 sphere and the purpose of the workshop. Below this is a "Description" section. On the right side of the page, there is a "Provide feedback on this project" button and a "DIVISIONS" section listing the Division of Behavioral and Social Sciences and Education.

NATIONAL ACADEMIES Sciences Engineering Medicine

SEARCH Q

About Us Events Our Work Publications Topics Engagement Opportunities

Foundations of Data Science for Students in Grades K-12: A Workshop

SHARE f t in ✉

- About
- Description
- Committee
- Sponsors
- Past Events
- Contact

We live in a world defined by data. Individuals who can work with data are in high demand, but too few professionals are prepared to meet the need. Ultimately, the challenge reaches well down into the K-12 sphere -- our future data scientists are in today's elementary, middle, and high schools. This summer, there will be a two-day workshop to delve more deeply into the research around these issues. The workshop will bring together a diverse set of stakeholders to advance the conversation around what is needed in grades K-12 to enable students to navigate the emerging data-driven world.

Description

The National Academies of Sciences, Engineering, and Medicine will convene a public workshop on the *Foundations of Data Science for Students in Grades K-12*. The workshop will explore the questions, such as the following:

Provide feedback on this project

DIVISIONS
Division of Behavioral and Social Sciences and Education

The background features a city skyline at dusk or dawn, with a network of white lines and dots overlaid. On the left, there are three circular icons: a line graph, a building, and a person. On the right, there is a circular icon with a building. The central text is on a dark blue rectangular background.

NATIONAL ACADEMIES

*Sciences
Engineering
Medicine*

**Foundations of Data Science for Students in Grades K-12 A Workshop Days 1 and 2 |
National Academies**

Foundations of Data Science for Students in Grades K–12



Proceedings of a Workshop

March
2023

New

Sep 2022

This paper was commissioned for the *Workshop on Foundations of Data Science for Students in Grades K-12*, whose work was supported by the Valhalla Foundation. Opinions and statements included in the paper are solely those of the individual authors, and are not necessarily adopted, endorsed, or verified as accurate by the *Workshop Planning Committee on Foundations of Data Science for Students in Grades K-12*, the Board on Science Education, the Board on Mathematical Sciences and Analytics, the Computer Science and Telecommunications Board, or the National Academy of Sciences, Engineering, and Medicine.

Previewing the National Landscape of K-12 Data Science Implementation

Zarek Drozda, University of Chicago
Davis Johnstone, Florida State University
Brooke Van Horne, University of Michigan

Data is undeniably changing our world. The rise of “big” or complex data, increasing computational power, and global connectivity have given rise to the emergent field of data science, increasingly distinguished from related fields both in technique and scope (Donoho, 2017). These changes have also changed the nature of daily career, personal, and civic engagement. Stakeholders in education (National Research Council, 2012) and the popular press (Pfeakemonics, 2019) have advocated that *all* students should learn about modern data methods and uses. Data education researchers have expressed that we are in a “state of emergency” with the speed and scale of these technological transformations, especially given students now encounter data several times a day (National Center for Education Research, 2021). How has K-12 education responded? This paper will provide a preview of the national landscape of K-12 data science implementation through existing frameworks and policy, case studies on implementation models from across the United States, and educator experiences.

Content Frameworks

Content expectations across multiple school subjects in U.S. primary and secondary education already incorporate at least some learning about data collection, utilization, and analysis. Data-related concepts consistently appear in mathematics, science, computer science, and social studies across states. These existing standards may provide the building blocks or even partially comprise a *data science* education. However, stakeholder interviews cautioned the degree to which these concepts are actually taught during the school day may vary widely – meaning there is no guarantee students are necessarily learning the concepts listed here. Significant technological changes and the speed of digital transformation have also created a challenging moving target for curricular relevance. Recent efforts both domestically and internationally have attempted to articulate discrete data science learning experiences, primarily for secondary students. Both existing and new frameworks relevant to data science education include, but are not necessarily limited to:

- **Next Generation Science Standards (NGSS)**, built from *A Science Framework for K-12 Science Education* (2011), outlines eight practices of science and engineering that are essential for all students to learn. NGSS standards expect students to demonstrate both topic knowledge and skills specific to each practice area concurrently. (NGSS, 2013, 1). Especially relevant practices of the NGSS framework include Practice 4 (“Analyzing and interpreting data”) and Practice 5 (“Using Mathematics and Computational Thinking”) (ibid), both included in Appendix F – Science and Engineering Practices. In K-2, students

Data Science & Literacy Act of 2023

118TH CONGRESS
1ST SESSION

H. R.

To direct the Secretary of Education to mi
increasing access to data literacy educati

IN THE HOUSE OF REP

Ms. STEVENS introduced the following bil
Committee on

A BIL

To direct the Secretary of Educat
the purpose of increasing acce
cation, and for other purposes.

1 Be it enacted by the Senate

2 tives of the United States of Amer

3 SECTION 1. SHORT TITLE; TABLE

4 (a) SHORT TITLE.—This

5 “Data Science and Literacy Act

6 (b) TABLE OF CONTENTS.—

7 this Act is as follows:

Sec. 1. Short title; table of contents.

Sec. 2. Findings.

EducationWeek

SIGN IN

SUBSCRIBE

LEADERSHIP

POLICY & POLITICS


TEACHING & LEARNING

TECHNOLOGY

MATHEMATICS

Students’ Data Literacy Is Slipping as Jobs Demand the Skill

By Sarah Schwartz — February 14, 2023 2 min read




K-12 EDUCATION

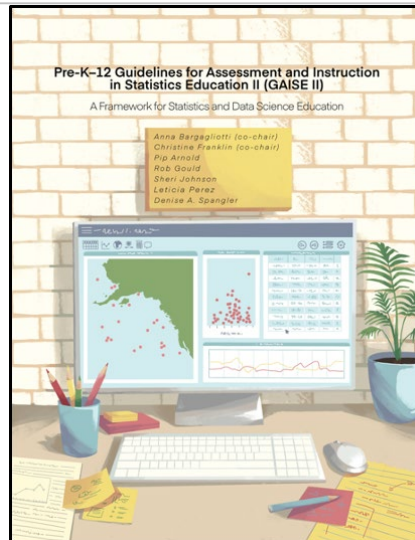
New Legislation to Boost Data Science in K-12 and Higher Ed

The Data Science and Literacy Act introduced last month aims to improve, and increase access to, data science education by funding professional development, new curricula and STEM equity programs.

March 14, 2023 • Brandon Paykamian



National context: data edu. in existing standards

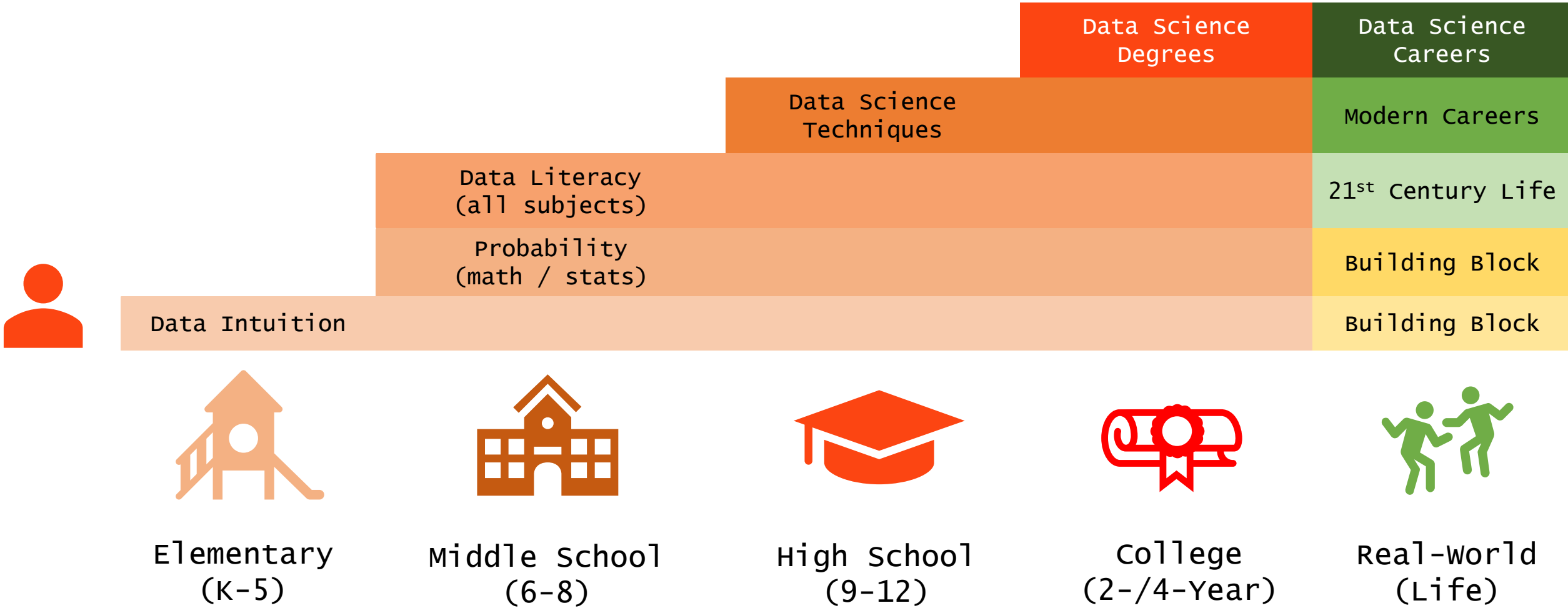


1. Data collection (NGSS, K-12) (CCSS Math K-5, via measurement) (CS, K-2, tech / digital tools focus) (GAISE II, A)
2. Data tables (NGSS, 3-5) (CCSS, HS) (CS, 6-8, tables for data storage) (GAISE II, B)
3. Basic variance (mean / median / mode) (6-8 NGSS) (CCSS HS) (GAISE II, A)
4. Variables in data (GAISE II, A) (NGSS, P3, 3-5) (CCSS, HS)
5. Statistical or inference-based questions (CS, K-2) (CCSS, HS) (NGSS, P4, 3-5) (GAISE II, A)
6. Data visualizations (dot plot, histogram, box plots) (NGSS, 3-5) (CCSS HS) (CS, K-2) (GAISE II, A, as variability)
7. Outlier data (CCSS Grade 8, HS) (GAISE II, C)
8. Data types (qualitative, quantitative, etc.) (NGSS, K-2) (CCSS, 8) (CS 6-8, as characters, noms, bits) (GAISE II, A)
9. Correlation vs. causation (NGSS, P4, 6-8) (CCSS, HS) (CS, 9-12, in prediction) (GAISE II, C)
10. Function / Model Fit (NGSS, P4, 9-12) (CCSS HS, emphasizes linear, quadratic, and exponential models; residuals) (CS, 6-8, focus on tech fit)
11. Slope / intercept / correlation coefficient (NGSS, P4, 9-12) (CCSS, HS) (GAISE II, C)
12. Sample selection, sample vs. population (NGSS, P4, 9-12) (CCSS, HS) (GAISE II, B)
13. Bayesian probability; updates to priors (NGSS, P4, 9-12) (GAISE II) (CS K-12, 6-8)
14. Units, ratios, percents, compound units, basic algebra (NGSS, P5, 9-12) (CCSS, throughout)
15. Analysis types: sample surveys vs. experiments vs. observational studies (CCSS HS) (GAISE, C) (U.T. Dana Center)
16. Sampling: random sampling, sample vs. population (CCSS 6-8) (CS K-12 6-8, simulation) (GAISE, B)
17. Randomization (CCSS, HS) (GAISE II, B)
18. Compare two things with data:
 - a. NGSS: two alternate solutions (P4, 3-5)
 - b. CCSS HS: two treatments & significance (or two distributions) (6-8)
 - c. GAISE II: two groups & association between two variables (A)
19. Data collection from modern tech devices (NGSS, devices only) (CS, devices & online data) (GAISE II, devices & online data)
20. Data cleaning (GAISE II, A) (CS, 6-8)
21. Limitations of data (NGSS, P4, 6-8) (GAISE II, B) (CS, 3-5)

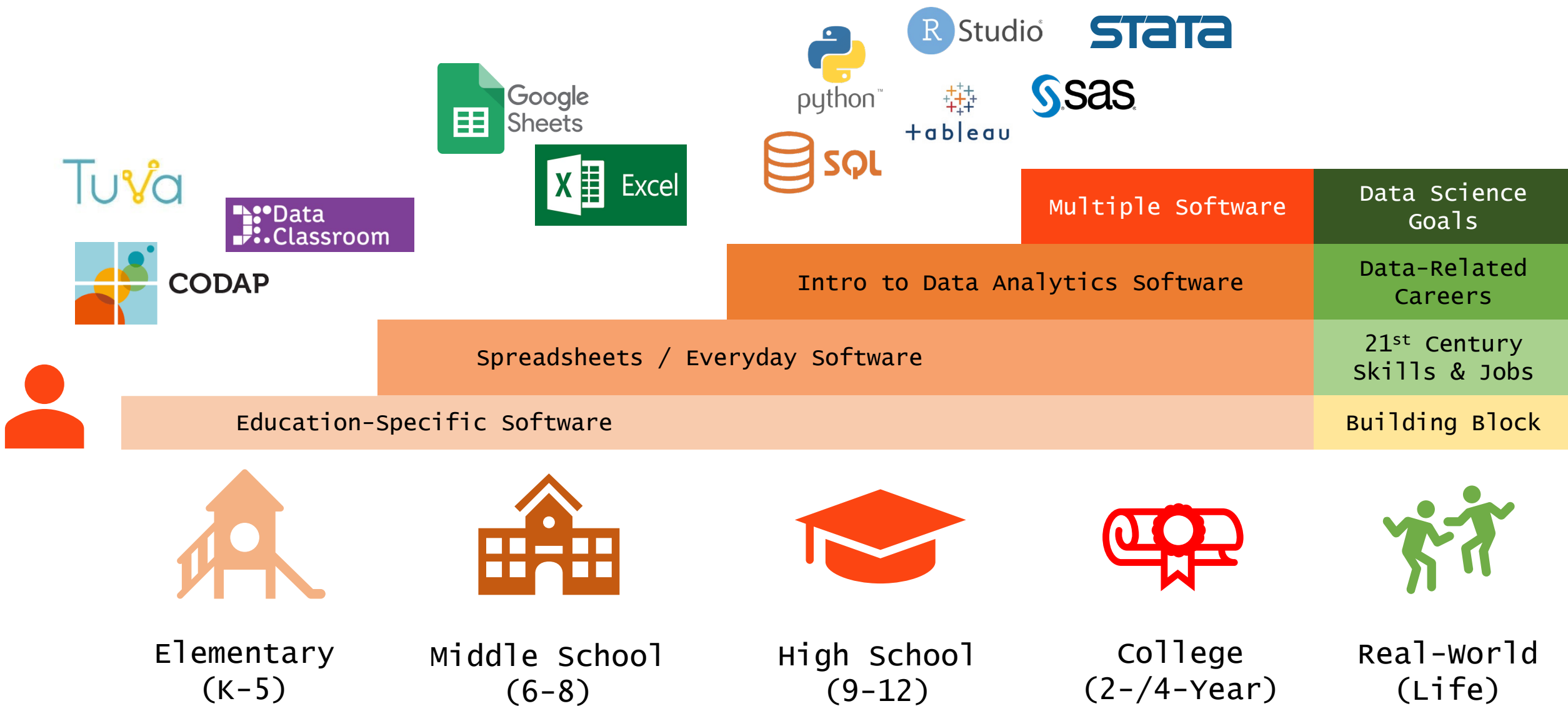
Possibly not enough? Teachers told us why:

- **Not actually taught:** existing data standards often cut, brushed-over, or in the background;
 - Low teacher confidence
 - Perception of assessments not prioritizing
- **Technology is missing:** students enjoy authentic technology, but few and far between;
 - DS programs have found students (and teachers!) enjoy the innovation
 - K-12 standards treatment of tech is skimpy: brief mentions of spreadsheets, calculators, hand-held sensors
- **Data ethics is missing:** existing standards only highlight data privacy;
 - Little mention of bias in datasets, ML models, and the resulting algorithms
 - Little mention of “fact-based authority” of data and ways it can be manipulated
- **Methods are too simplistic:** we need modern methods and processes > finite list of skills

Building modern data education:



With relevant tech tools:

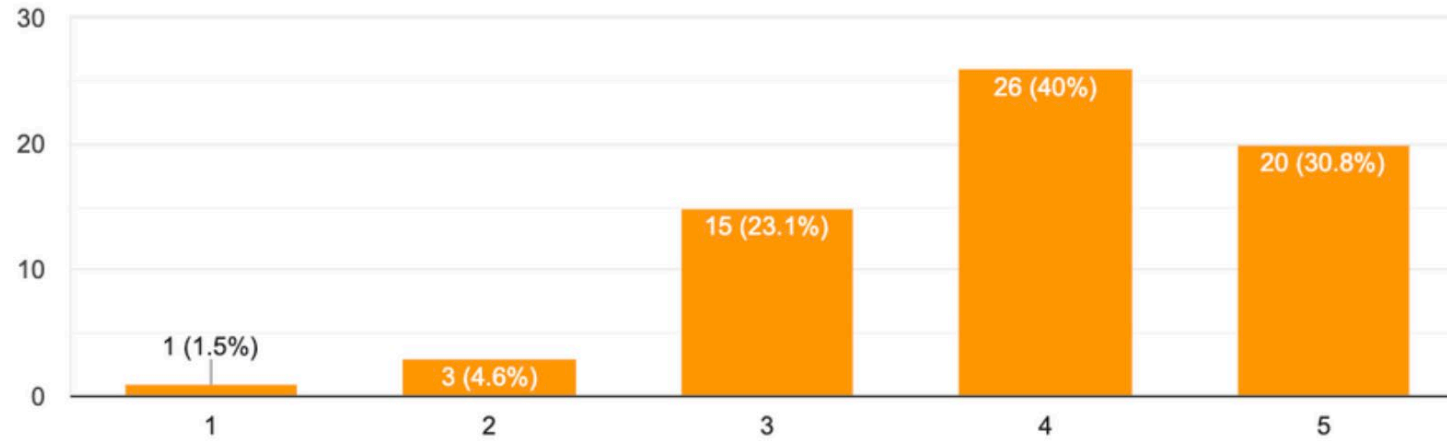


What convinced you to take this on?

How useful do you think learning data science would be to a future career/your dream career?



65 responses

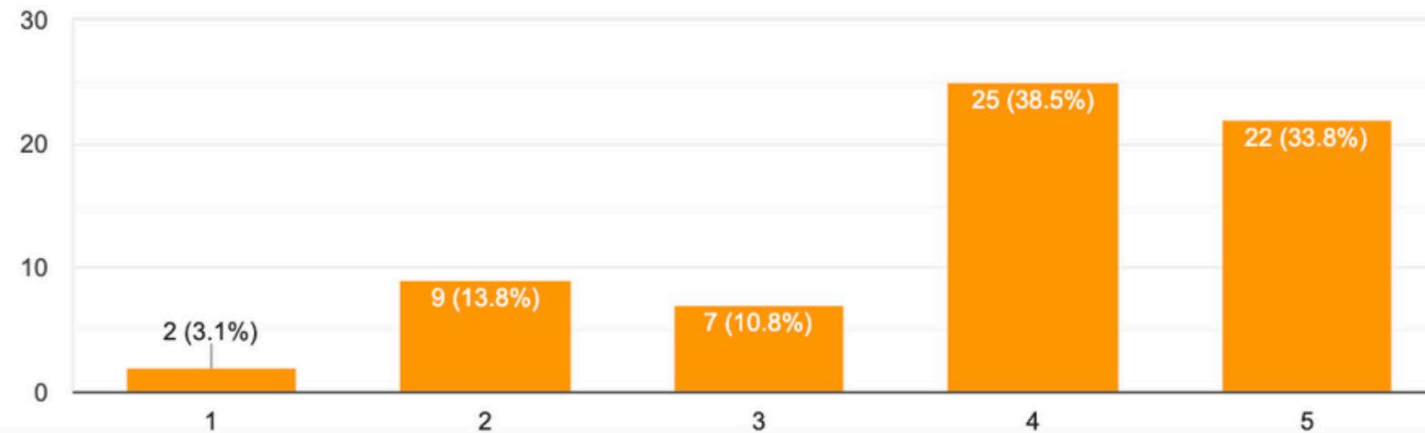


6

How useful do you think learning the basics of data in high school would have been to your college experience?



65 responses



What convinced you to take this on?

Summer learning extensions:



bit.ly/3NT7vXn



#1



MH Office Hours

#2

Advocacy Deck

<https://bit.ly/dataedudeck>



Messaging guide

DS4E Resource Hub

<https://bit.ly/data-edu-resources>



Classroom resources

Leveraging Federal Dollars

<https://bit.ly/data-edu-federal-guidebook>



Funding help

State Recommendations

<https://bit.ly/data-edu-recs>



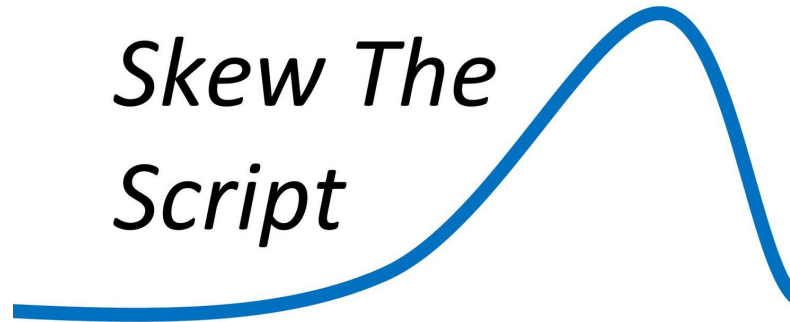
Systems change

One-Year



Integrated

*Skew The
Script*



BOOTSTRAP
Equity • Scale • Rigor

Platform



Want to get involved?



@ The University of Chicago

www.datascience4everyone.org



Keep us updated on your progress!



bit.ly/ds-program-share



Q&A

Data Science 4 Everyone
The University of Chicago
bit.ly/ds4e-sign-in

