

# Toward a Framework for **Justice-Oriented Data Science** **Education** in K–12 Schools

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# **Data Science (DS)**

**in a “datafied” society**





# Data science is fundamentally connected to justice issues

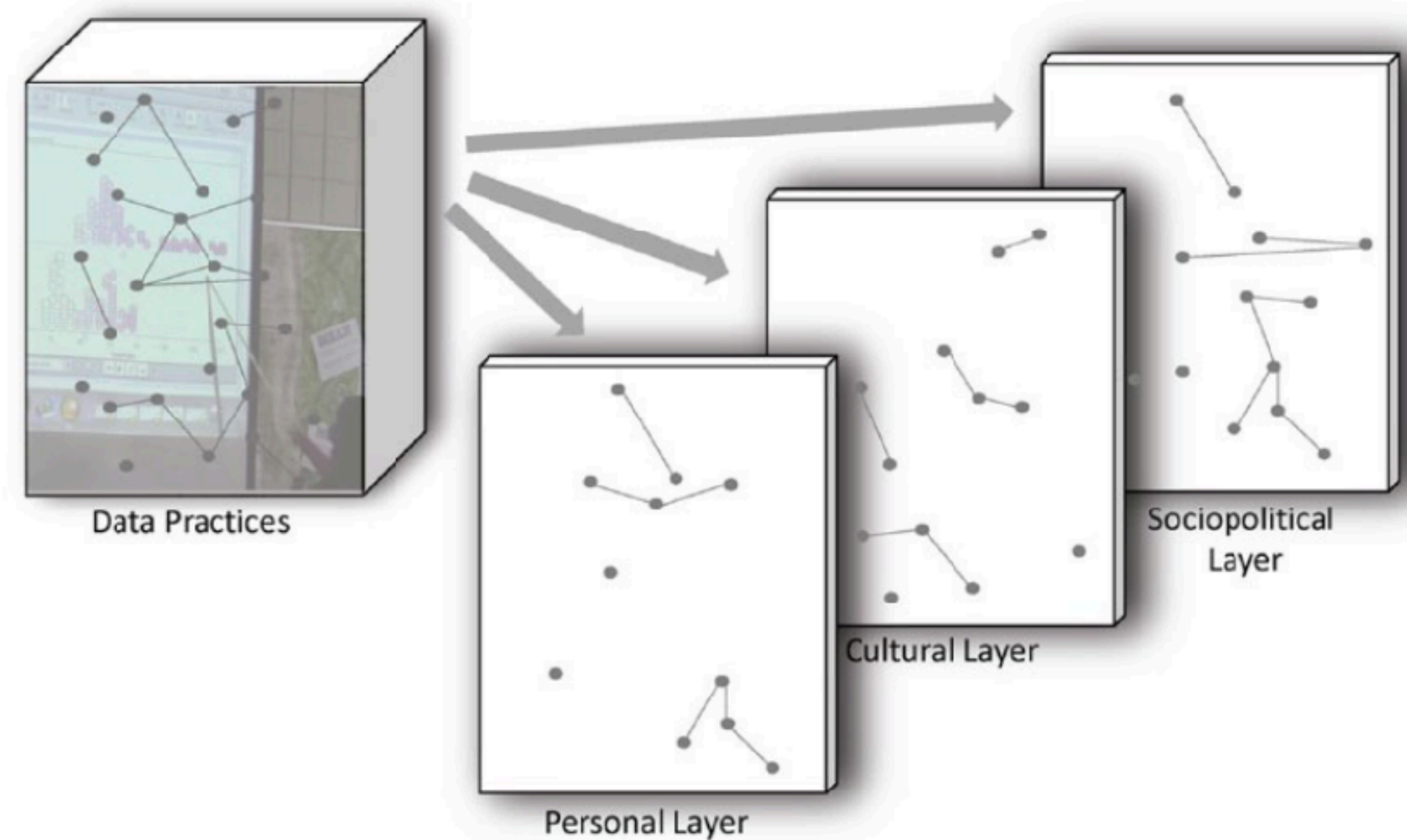
Data are not neutral

Data practices are very 'human'

Data products empower and dispower people and communities

# A humanistic stance toward K-12 Data Science Education

- Personal
- Cultural
- Sociopolitical



Adapted from Lee et al. (2021)

(see also Irgens et al., 2020; Pangrazio & Selwyn, 2021; Wilkerson & Polman, 2020)



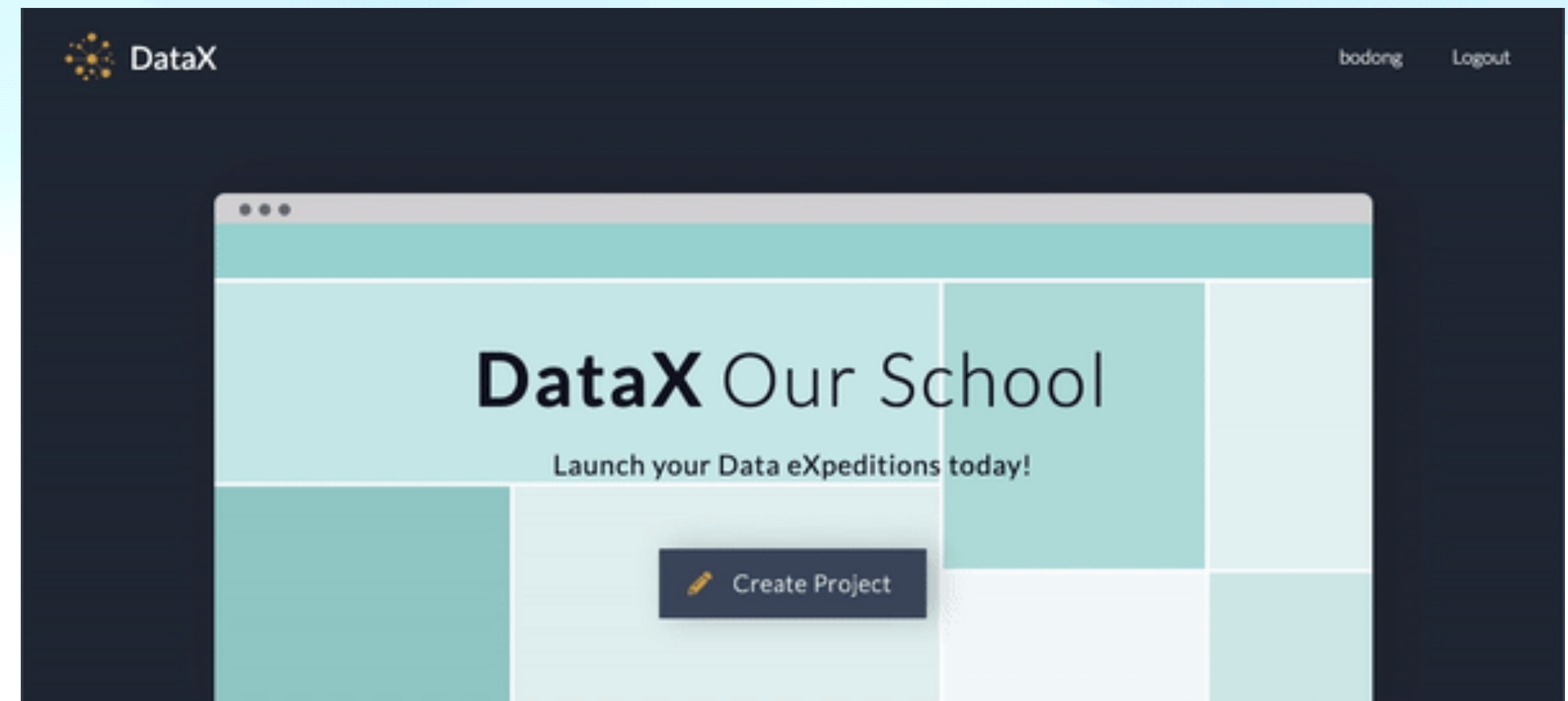
**How to create opportunities for *everyone* to  
work with data, and to imagine  
a more just future?**

# DataX Project

funded by NSF DRK-12



- Integrate Data Science in secondary science and social studies
- Three design components
  - *Curriculum*
  - *Technology*
  - *Pedagogy*
- Design-based research and participatory design



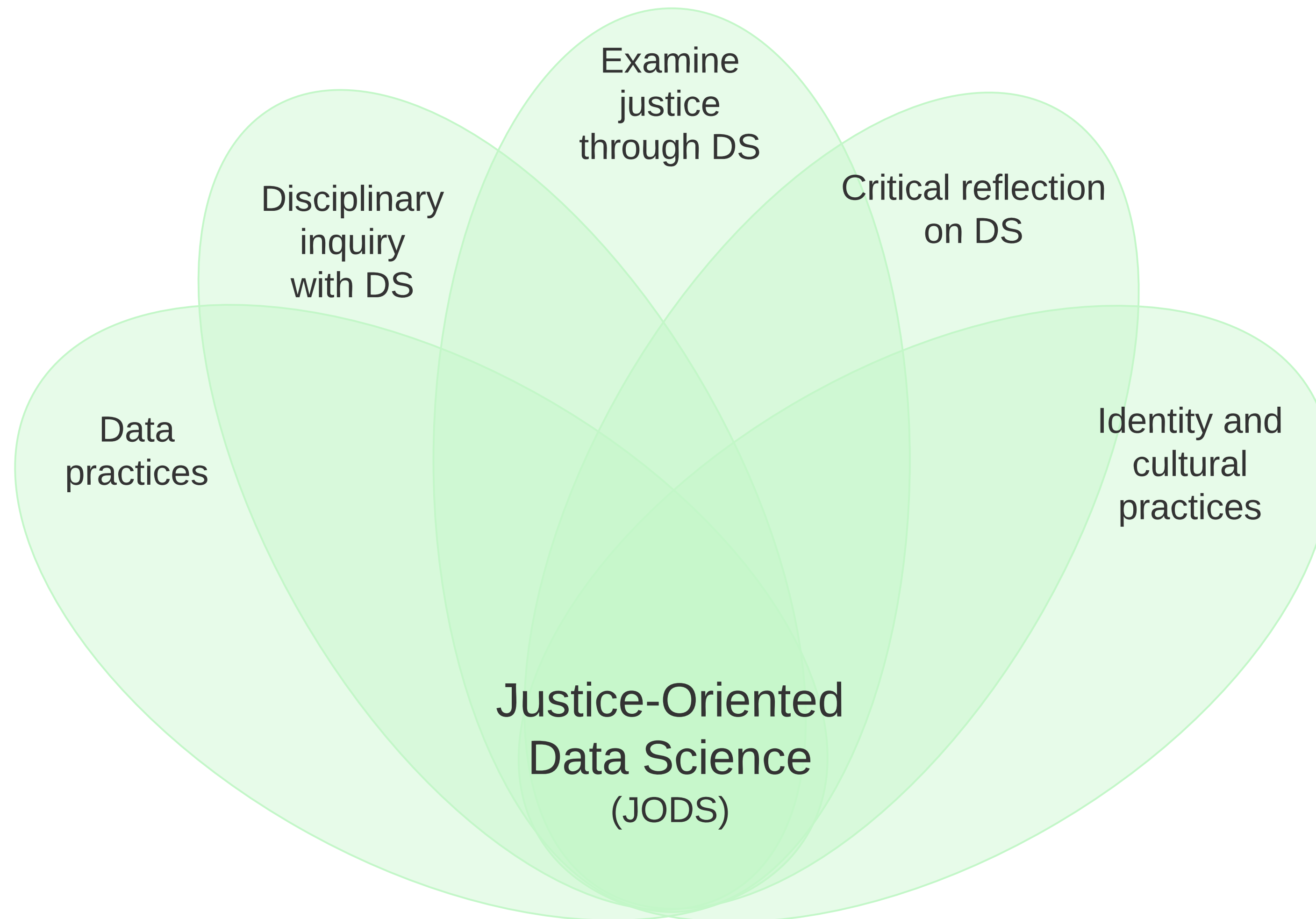


# Existing K-12 DS curricula and their connection with justice issues

1. General discussion of bias
2. Standalone units on data ethics
3. Exploring justice in contexts (e.g., the criminal justice system)

Data Science Curriculum Review - 20220418 : Public			
Title	Organization	Link	Grade level
Introduction to Data Science (IDS)	UCLA CenterX	<a href="https://www.intro">https://www.intro</a>	Grades 9 – 12
CodeHS Data Science	CodeHS	<a href="https://codehs.co">https://codehs.co</a>	Grades 9 – 12
Explorations in Data Science	Youcubed, Stanford	<a href="https://hsdatasci">https://hsdatasci</a>	Grades 9 – 12
Data Science Lessons	Youcubed, Stanford	<a href="https://www.youc">https://www.youc</a>	Grades 6 – 8
Bootstrap:Data Science	Bootstrap	<a href="https://www.boot">https://www.boot</a>	Grades 6 – 8, Gi
Data Science Foundations	EVERFI	<a href="https://everfi.com">https://everfi.com</a>	Grades 9 – 12
Unit 9 - Data ('21-'22)	Code.org®	<a href="https://studio.coc">https://studio.coc</a>	Grades 9 – 12
Data Science for Beginners	Microsoft, Azure Clou	<a href="https://microsoft">https://microsoft</a>	Grades 9 – 12
AI4ALL Open Learning	AI4ALL	<a href="https://ai-4-all.or">https://ai-4-all.or</a>	Grades 9 – 12, C
What is going on in this graph?	NYTimes	<a href="https://www.nytir">https://www.nytir</a>	Grades 6 – 8, Gi
Data Classroom	Data Classroom	<a href="https://about.dat">https://about.dat</a>	Grades 6 – 8, Gi
Callysto	Callysto (Canada)	<a href="https://www.cally">https://www.cally</a>	Grades 6 – 8, Gi
CODAP	Concord Consortium	<a href="https://codap.cor">https://codap.cor</a>	Grades 6 – 8, Gi
Tuva Tools	Tuva	<a href="https://tuvalabs.c">https://tuvalabs.c</a>	Grades 1 – 5, Gi
How to Think Like a Data Scientist	Runestone	<a href="https://runestone">https://runestone</a>	Grades 9 – 12
Data Clubs	TERC in Cambridge, I	<a href="https://www.terc">https://www.terc</a>	Grades 6 – 8
Data Nuggets	MSU	<a href="https://datanugg">https://datanugg</a>	Grades 1 – 5, Gi
Discover Data	Discover Data	<a href="https://www.disc">https://www.disc</a>	Grades 6 – 8, Gi
CourseKata Statistics & Data Scienc	CourseKata	<a href="https://coursekat">https://coursekat</a>	Grades 9 – 12

# Justice-oriented data science (JODS)





## 1. DS practices

Learners work with data in authentic ways, including wrangling data, making data moves, generating data representations, and interpreting findings.

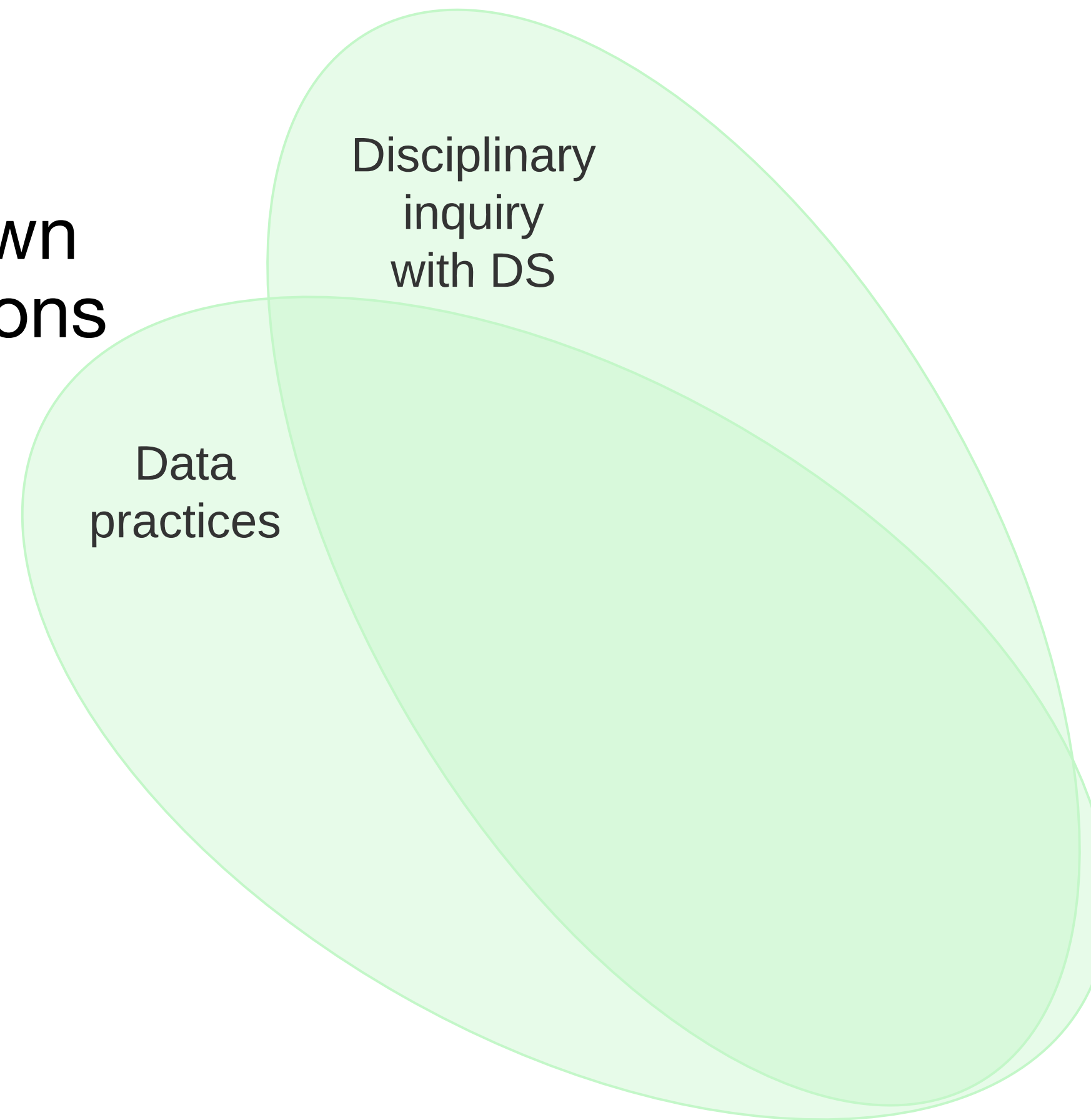


- Data cycle (Finzer, 2013)
- Data moves (Erickson et al., 2019)
- Data wrangling practices (Jiang & Kahn, 2020)
- Statistical thinking (Rubin & Mokros, 2018; Zieffler et al., 2018)
- Data practices and processes (Lee et al., 2022)



## 2. Disciplinary inquiry with DS

Learners engage in meaningful disciplinary or interdisciplinary inquiries in which they pose their own questions and answer these questions by analyzing data, while interacting and communicating with others.

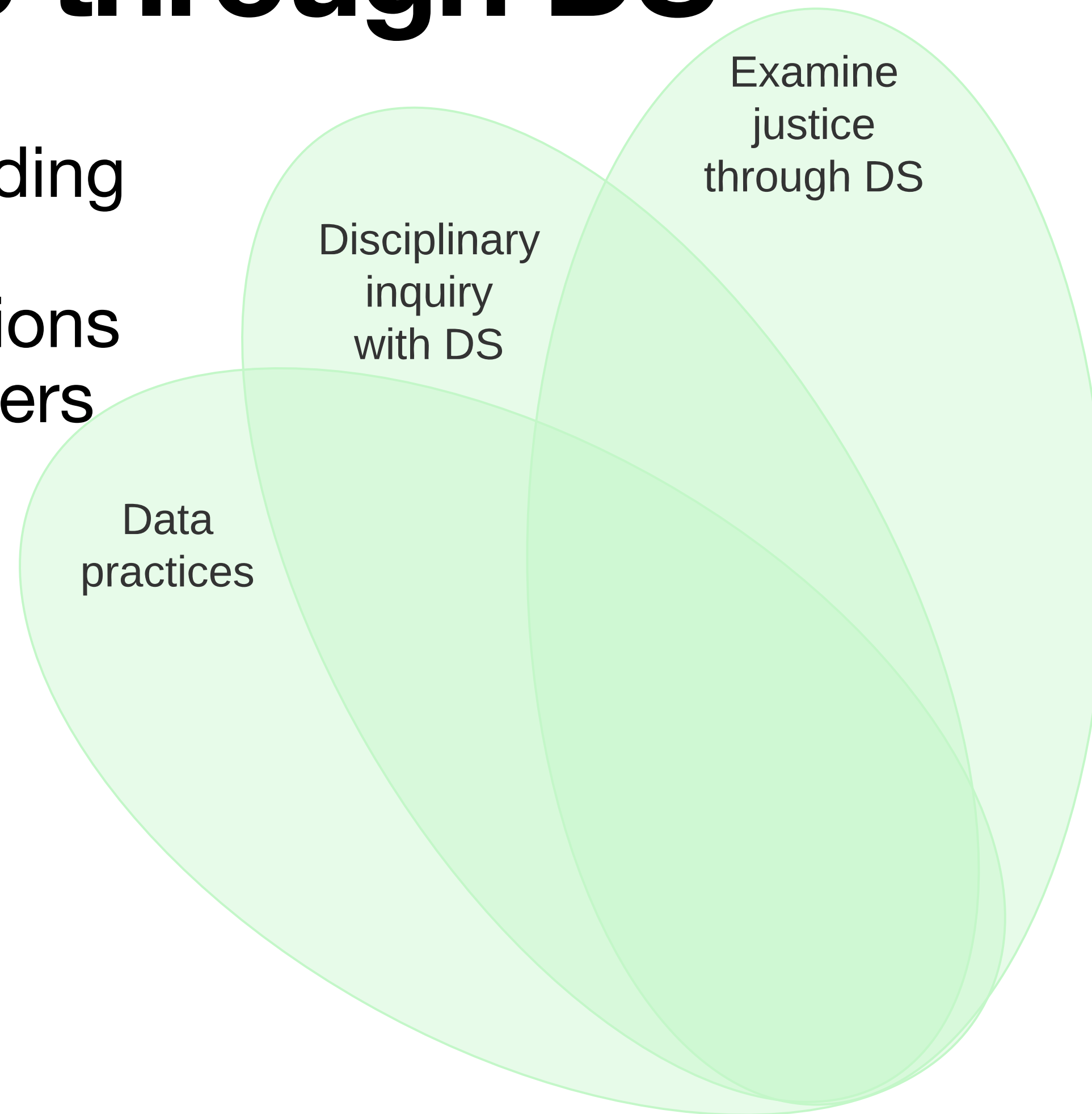


- Mathematics and science (Skovsmose, 2012; Weintrop et al., 2016)
- Historical reasoning (Shreiner, 2019)



## 3. Examine justice through DS

Learners develop their understanding of a range of justice issues (e.g., racial, climate) and their intersections through data investigations; learners mobilize data science to develop tools to tackle justice issues.



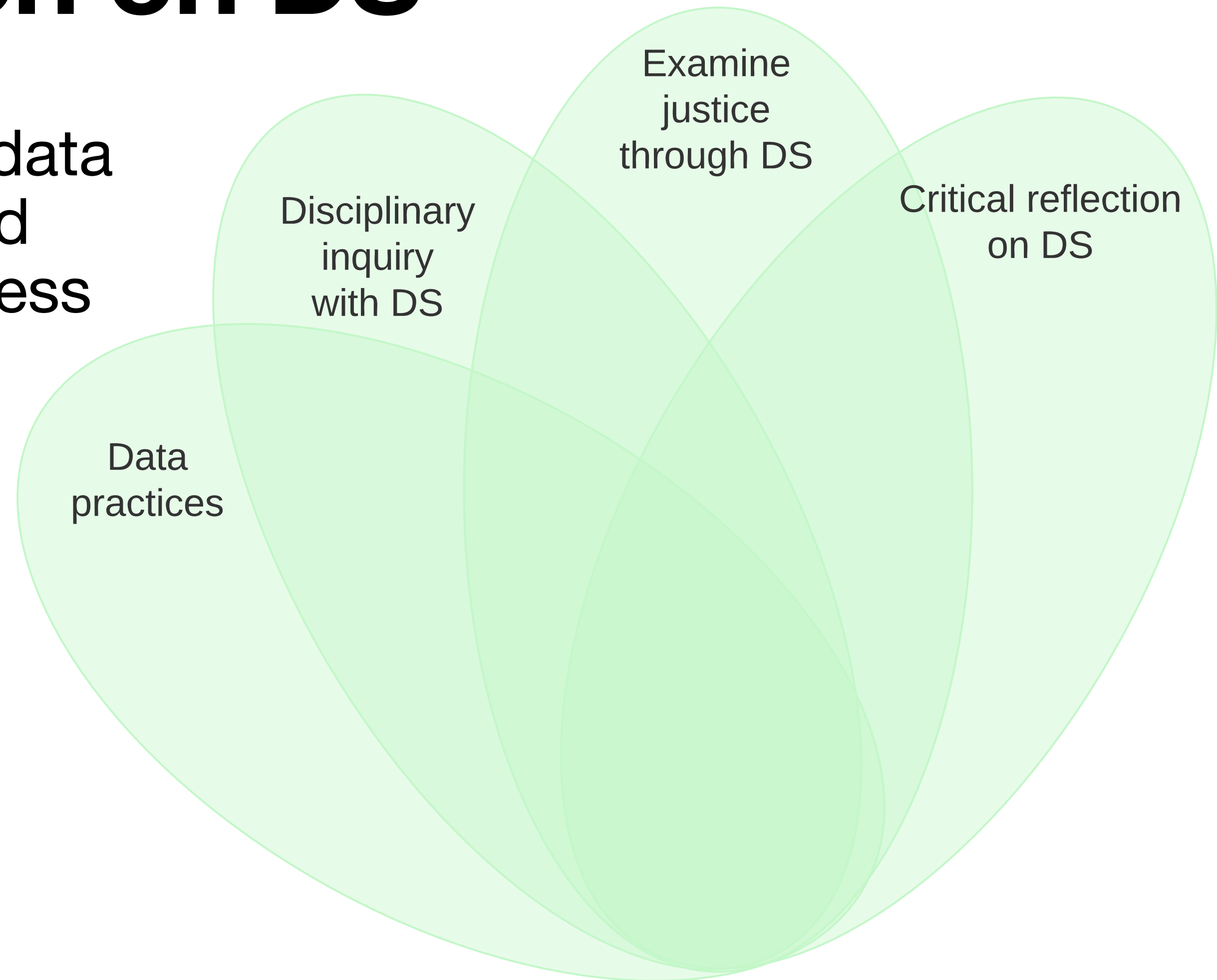
- Critical mathematics (Skovsmose, 2012)
- Critical data studies (Iliadis & Russo, 2016)
- Social justice in math (Wright, 2016)
- Data feminism (D'Ignazio & Klein, 2020; V. R. Lee et al., 2022)
- Critical data education (Pangrazio & Selwyn, 2021)



## 4. Critical reflection on DS

Learners consider the nature of data science as a field of research and practice, the ways in which fairness and biases are reflected in data science, and connections between data science and societal discourse.

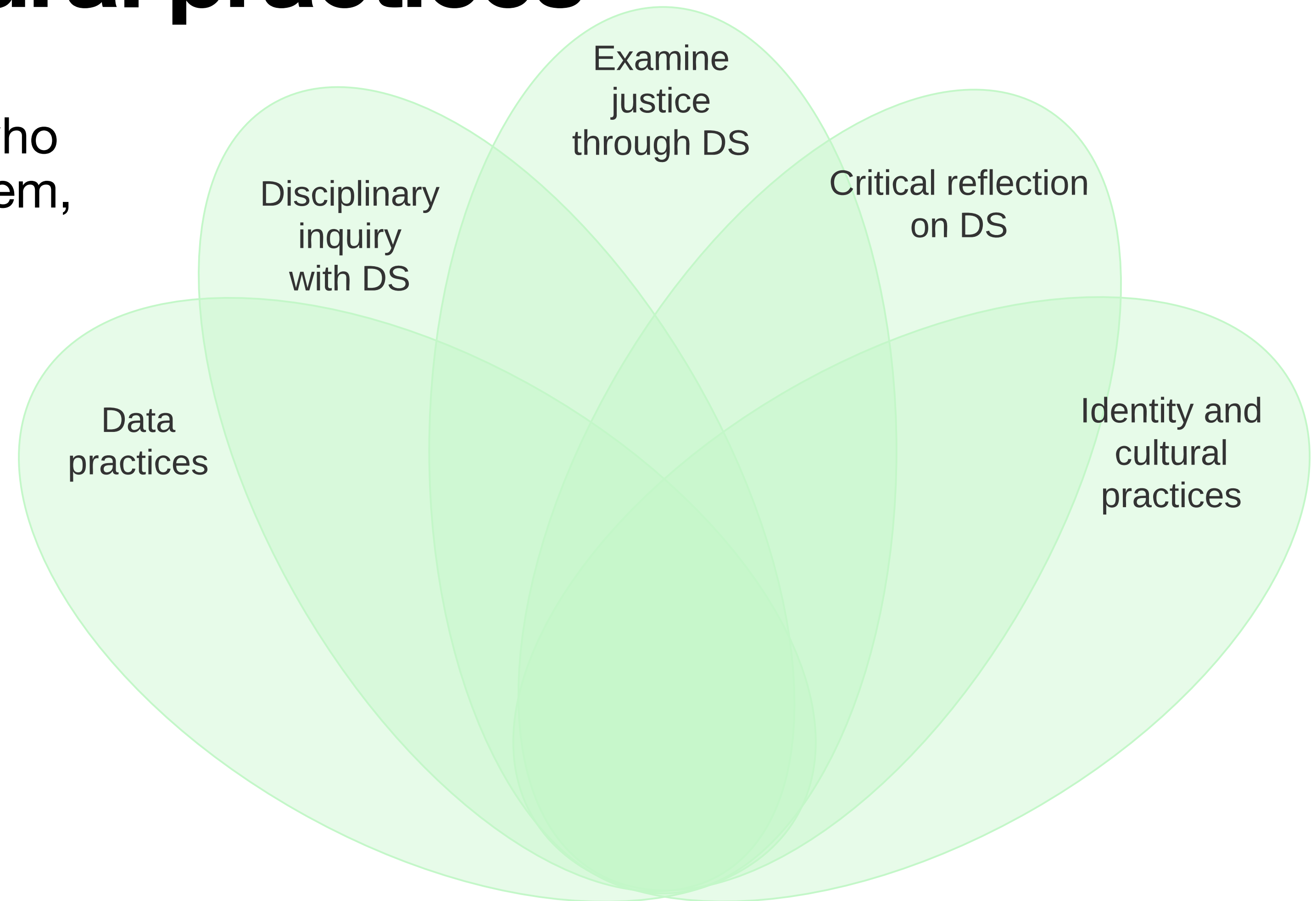
- A contrapuntal approach to learning (Philip & Sengupta, 2021)
- Critical “big data” literacy (Atenas et al., 2020; Sander, 2020)
- Algorithmic bias, auditing, accountability (Bozdag, 2013; Shen et al., 2021)





## 5. Identity and cultural practices

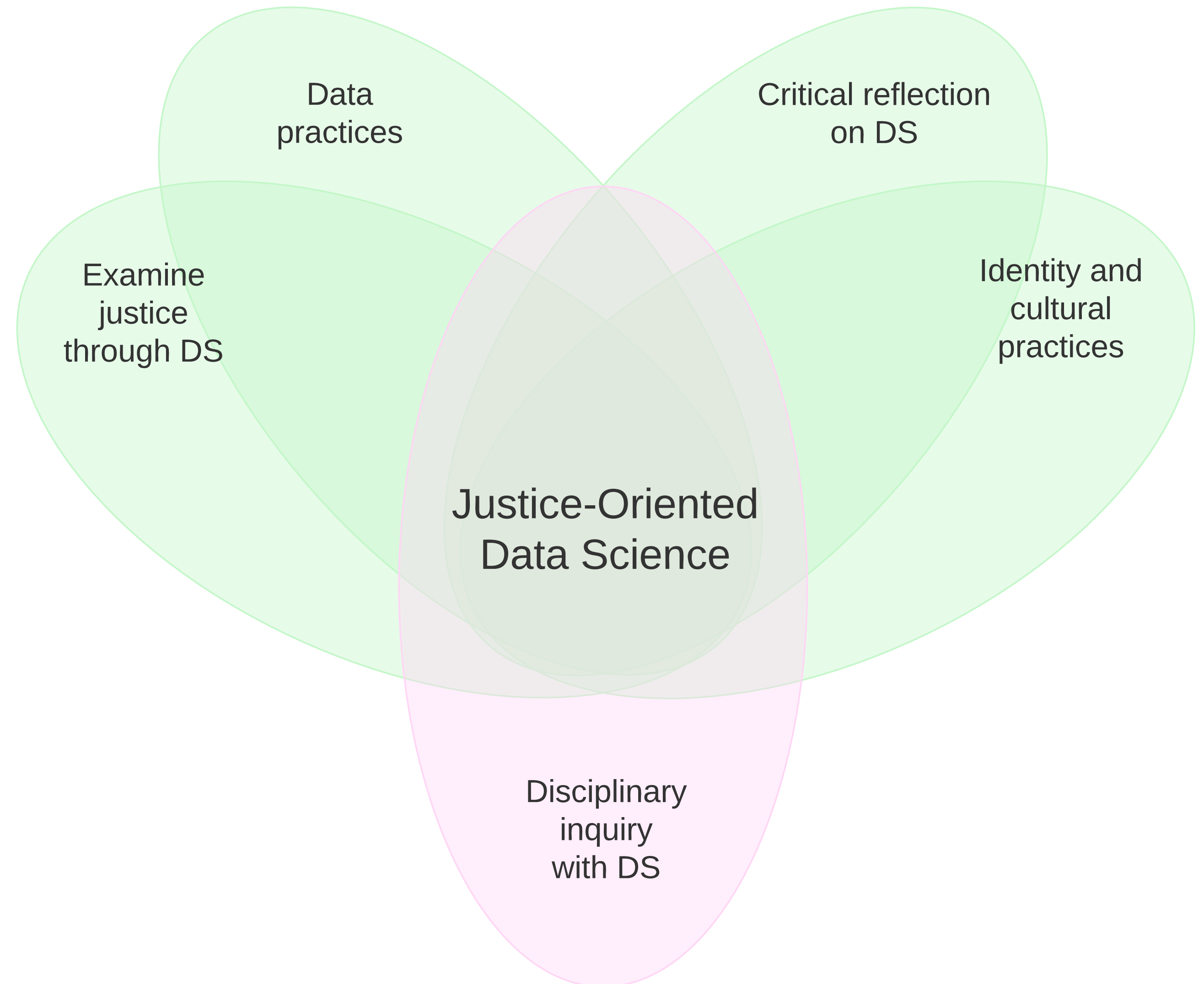
Learners see themselves as people who use data for purposes that interest them, recognize connections between data science and themselves and their communities, and identify ways to engage in data science in culturally congruent manners.



- Culturally responsive teaching (Hammond, 2014; Ladson-Billings, 2021)
- Democratic participation, self identity, family history (Kahn, 2020; Philip et al., 2013, p. 2013; Wilkerson & Polman, 2020)
- Hybrid language practices (Gutiérrez et al., 1999)
- Arts and data (Bhargava et al., 2016)

# Multiple entry points & pathways

- A JODS learning experience is dynamic and emergent.
- A learner could enter the JODS space from one particular area before connecting to overlapping areas and then expanding again into another area.





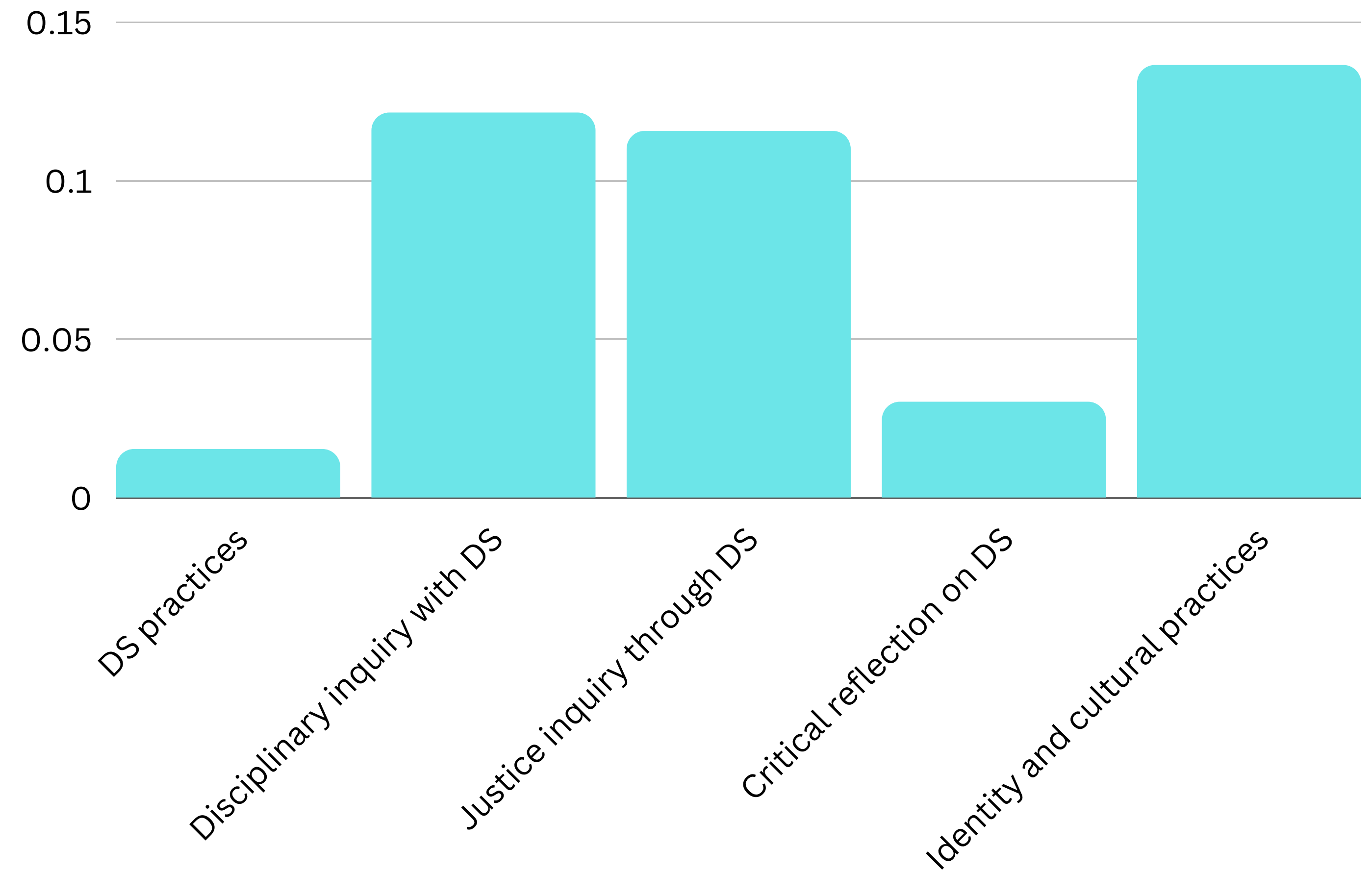
# Experimenting with the framework

*In which ways were the framework areas reflected in the participatory design workshop?*

- 3 school teachers and 4 researchers
- Transcripts of a virtual design workshop (180 minutes)
- Content analysis
  - Areas of the JODS framework
  - Design components (curriculum, pedagogy, and platform)
- Network analysis of codes
  - based on proximity (300 characters)

# Presence of framework areas

- All five areas of the framework were represented in the workshop conversation
- Some areas were more dominant than the others





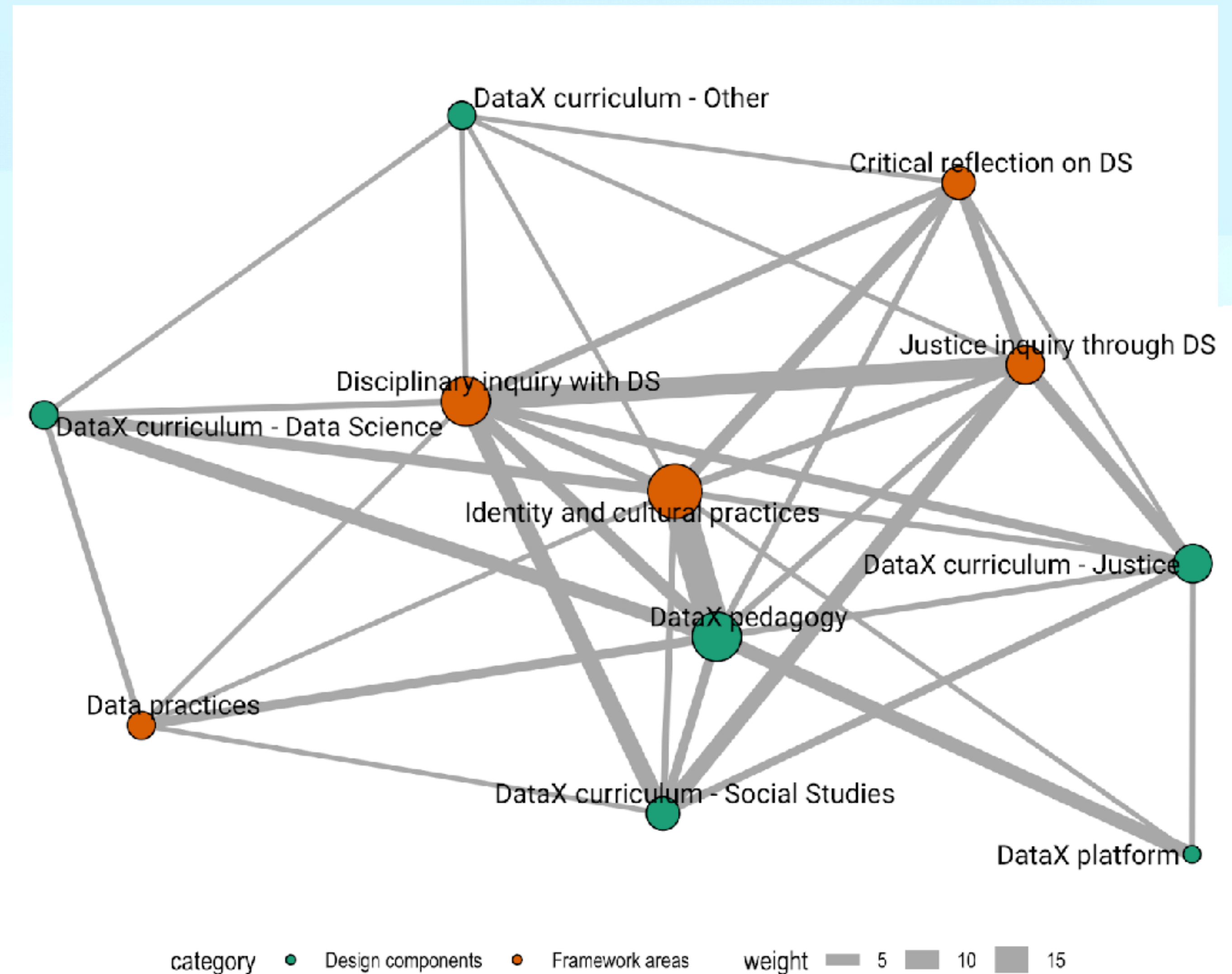
<b><i>Line</i></b>	<b><i>Timestamp</i></b>	<b><i>Transcript</i></b>	<b><i>Code</i></b>
467-470	1:14:46-1:15:30	R2: How do we build self-efficacy and overcome reifying beliefs like “I’m not good at math”, or “I don’t understand graphs” so that students believe they can be successful?	DataX Pedagogy Identity and Cultural Practices
471-474	1:15:41-1:16:24	R1: And how do we include the idea that oral stories can be more valued in different cultures? Maybe it pushes us to reconsider what counts as data?	Identity and Cultural Practices Critical Reflection of DS
475-481	1:16:27-1:17:16	T1: I have an activity where students create data about their favorite superheroes and try to prove which one is best as a low-barrier entry.	DataX Pedagogy DataX Curriculum Identity and Cultural Practices
487-488	1:18:15-1:19:12	T2: I have used maps with data as a different access point.	DataX Curriculum Disciplinary inquiry with DS
489-490	1:19:12-1:19:43	T1: I wonder if it would be possible to have students find bias in their own work or others and see how it could be improved.	Justice Inquiry through DS Critical Reflection on DS
491-492	1:19:43-1:20:31	R3: I want to call out these great connections between critical reflection and data science; what is collected, what is data, who gets to make those decisions?	Justice Inquiry through DS Critical Reflection on DS



# Connections

## among framework areas and with design components

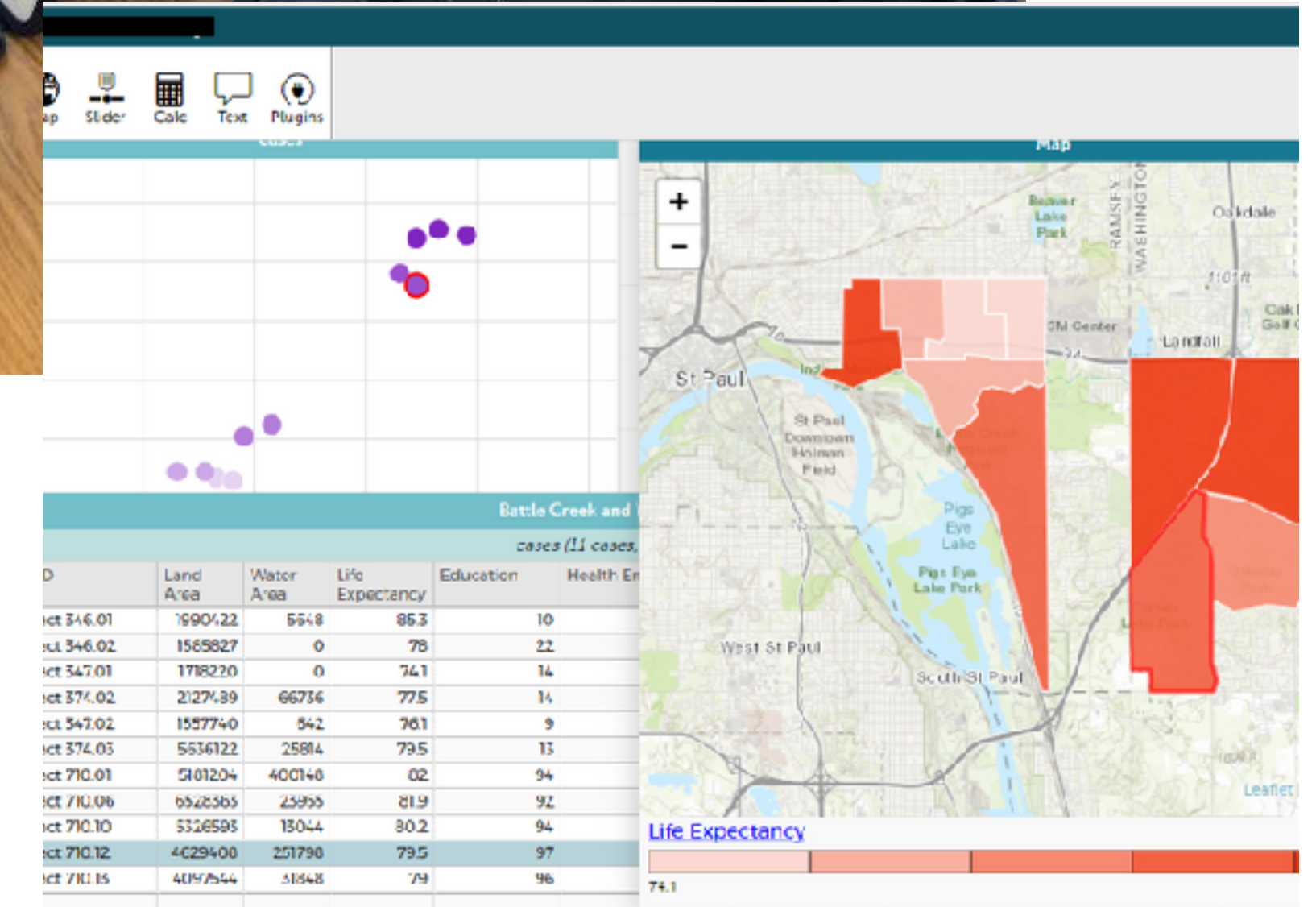
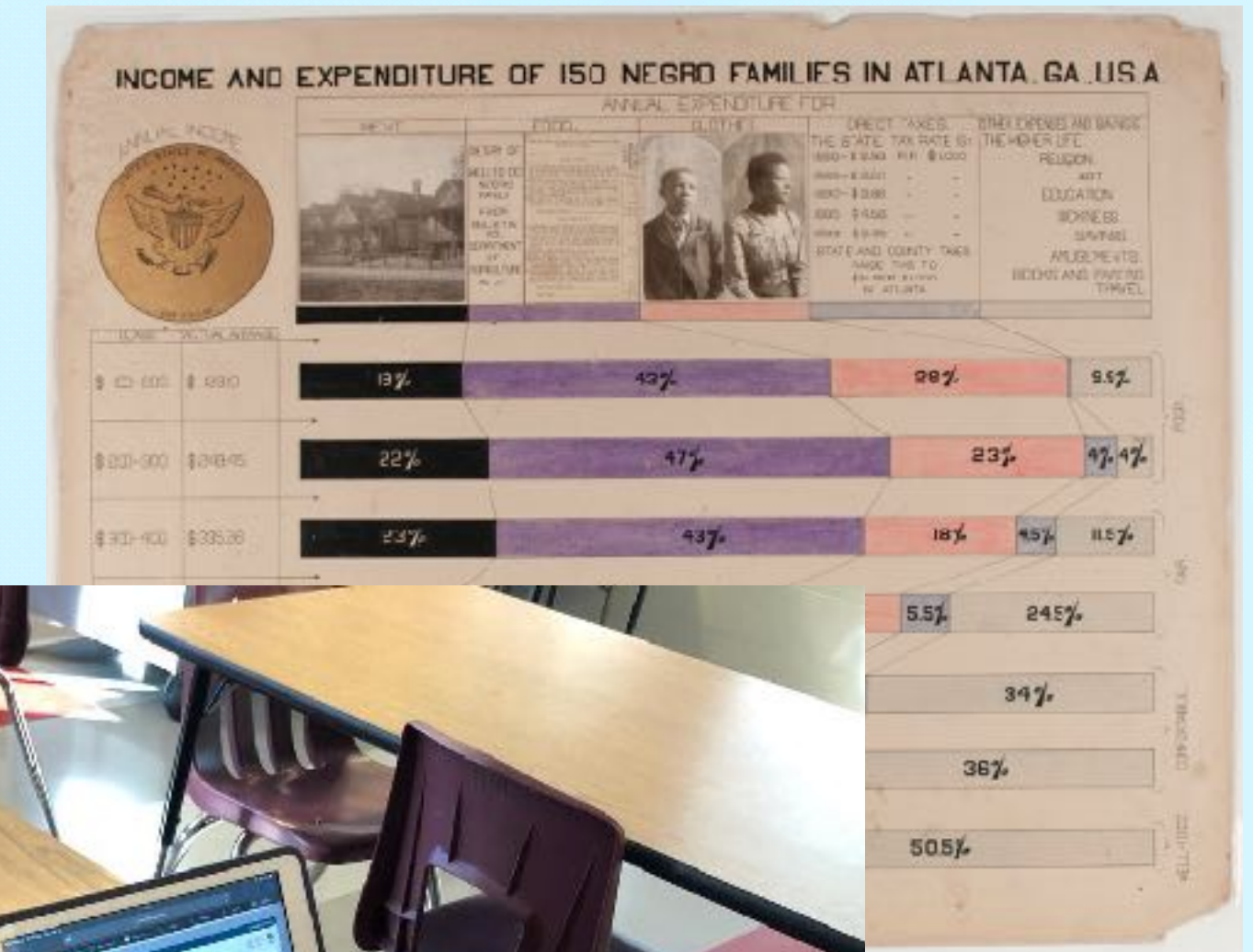
- *Disciplinary inquiry with DS* and *Justice inquiry through DS* frequently appeared near each other, so did *Critical reflection on DS* and *Identity and cultural practices*
- *Identity and cultural practices* appeared close to *DataX pedagogy*





# Discussion

- Imperative to integrate justice issues in data science education
- The JODS framework intends to offer educators, designers, and researchers a tool to guide the integration of disciplinary learning, data science, and justice issues
- Analysis of a design workshop with high school teachers demonstrated the presence of these areas and their rich connections
- Ongoing work will seek to refine the framework and enact it in curriculum designs





# Questions?

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**Project website: <https://bit.ly/ourdatax>**

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