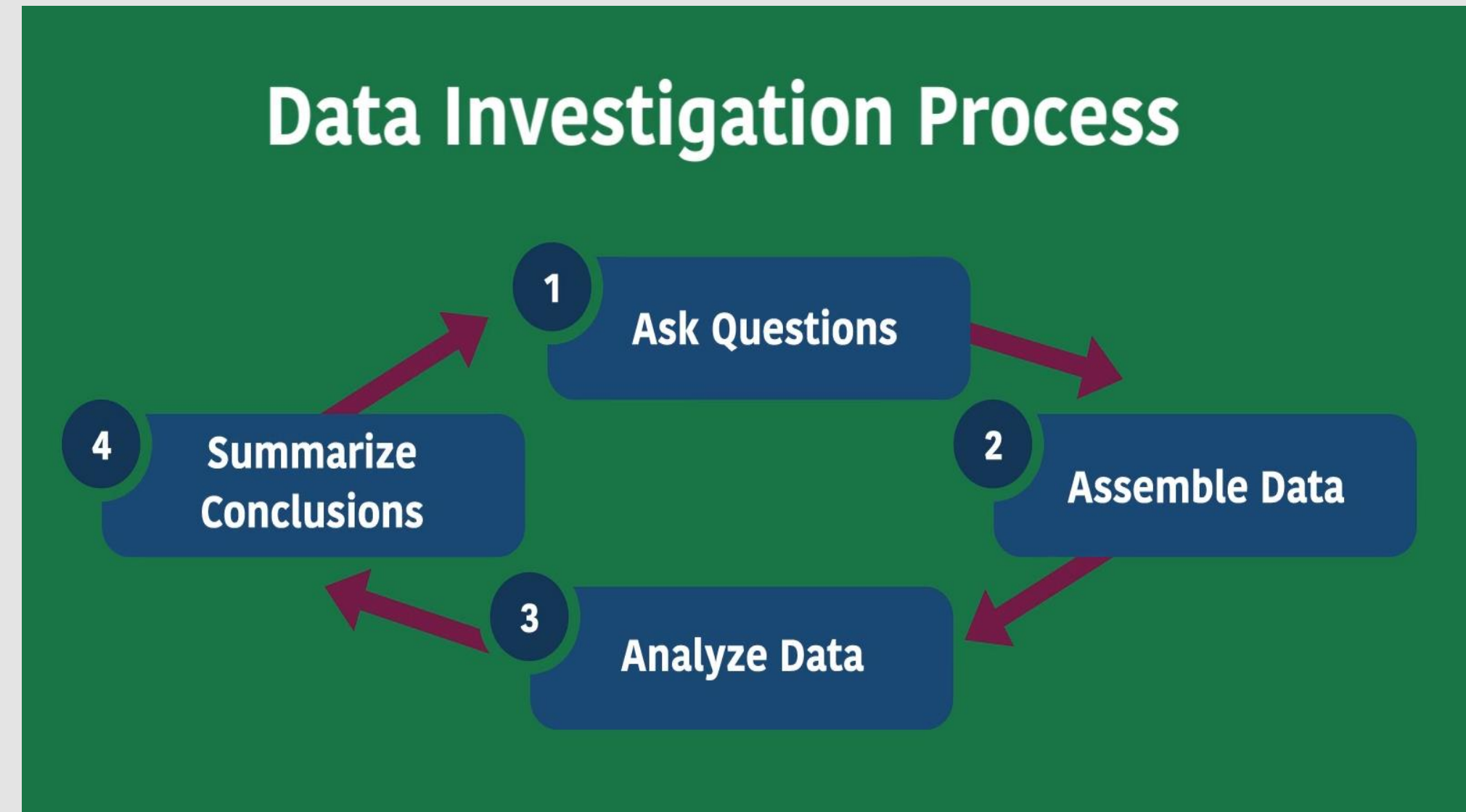


Building Statistical Thinking with Social Justice Investigations and Social Science Data

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The Intervention: The Strengthening Data Literacy across the Curriculum (SDLC) project has developed and studied two curriculum modules for non-AP high school statistics to promote interest and skills in statistical thinking and data analysis among diverse high school populations. Structured around a four-step data investigation process, the modules engage students with social-justice-themed data investigations using large-scale socioeconomic data from the U.S. Census Bureau and the Common Online Data Analysis Platform (CODAP).



Research Questions

- In what ways do SDLC modules and their components support students' interests in and learning of statistical concepts and practices?
- To what extent do students who use SDLC modules show improved understandings of important statistical concepts and greater interest in statistics and data analysis?

Research Design

- Design-based and mixed-methods
- 2018/19: Iterative development & alpha testing
- 2019/20: Iterative development & beta testing
- 2020/21: Beta testing; data analysis & dissemination

Participants

- From 2018/19 - 2020/21: 12 high school teachers of non-AP statistics; 5 high school social studies teachers; over 500 students (gr. 12)
- Schools have high % of students who are Black, Latinx, low-income, and ELs in Boston, MA region

Data: Classroom observations; teacher implementation logs & interviews; student focus group interviews & work samples; pre- and post-module student assessments

Analysis

- Qualitative data: *A priori* and open coding to examine conjectures linking curriculum design features with student outcomes
- Quantitative pre/post assessments: Paired samples *t*-tests



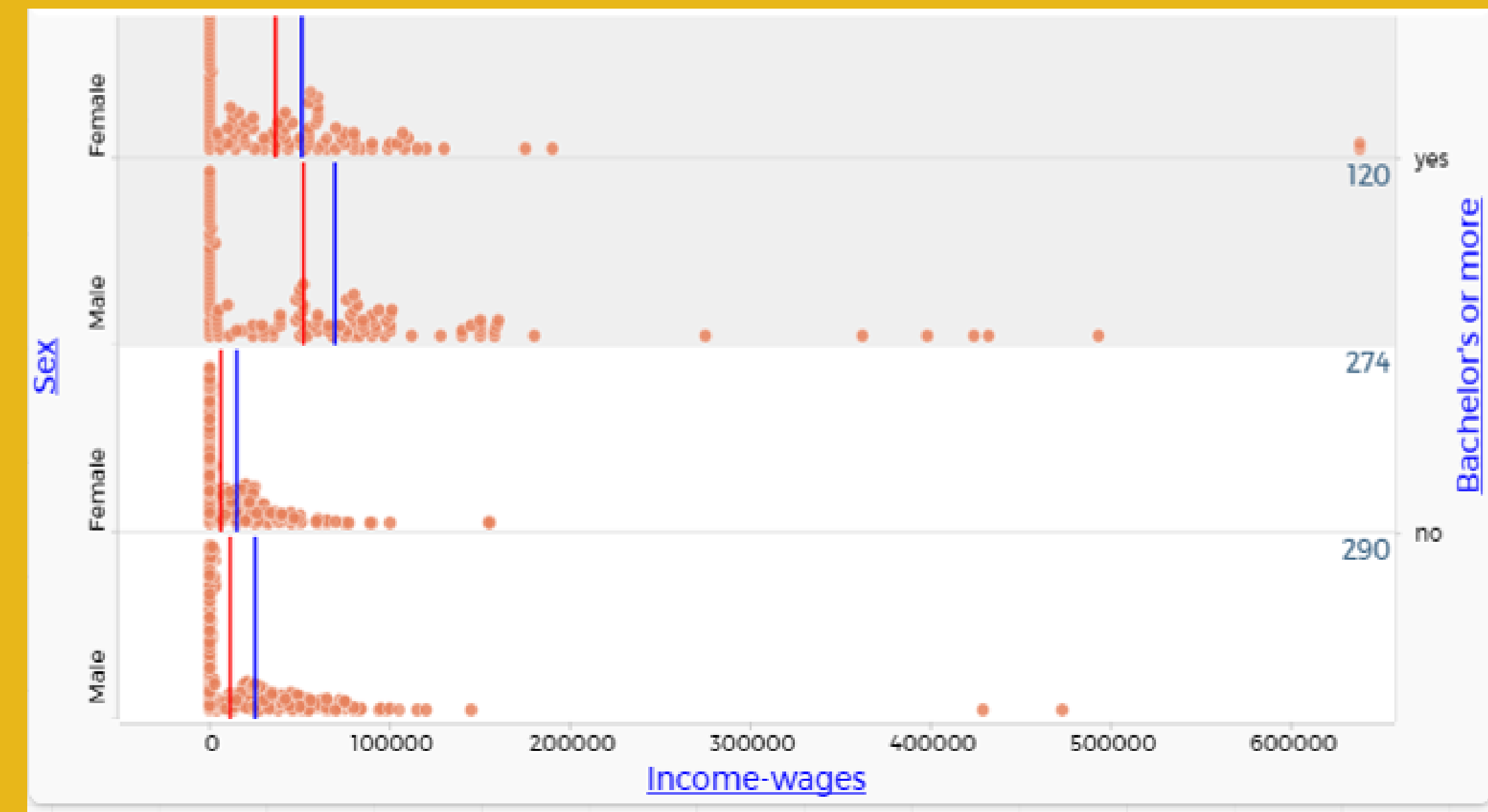
This project is funded by the National Science Foundation, grant #1813956. Any opinions, findings, and conclusions or recommendations expressed in these materials are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

SDLC Module: Investigating Income Inequality in the U.S.

This module consists of applied data investigations related to income inequality and focuses on describing, comparing, and making sense of quantitative variables.

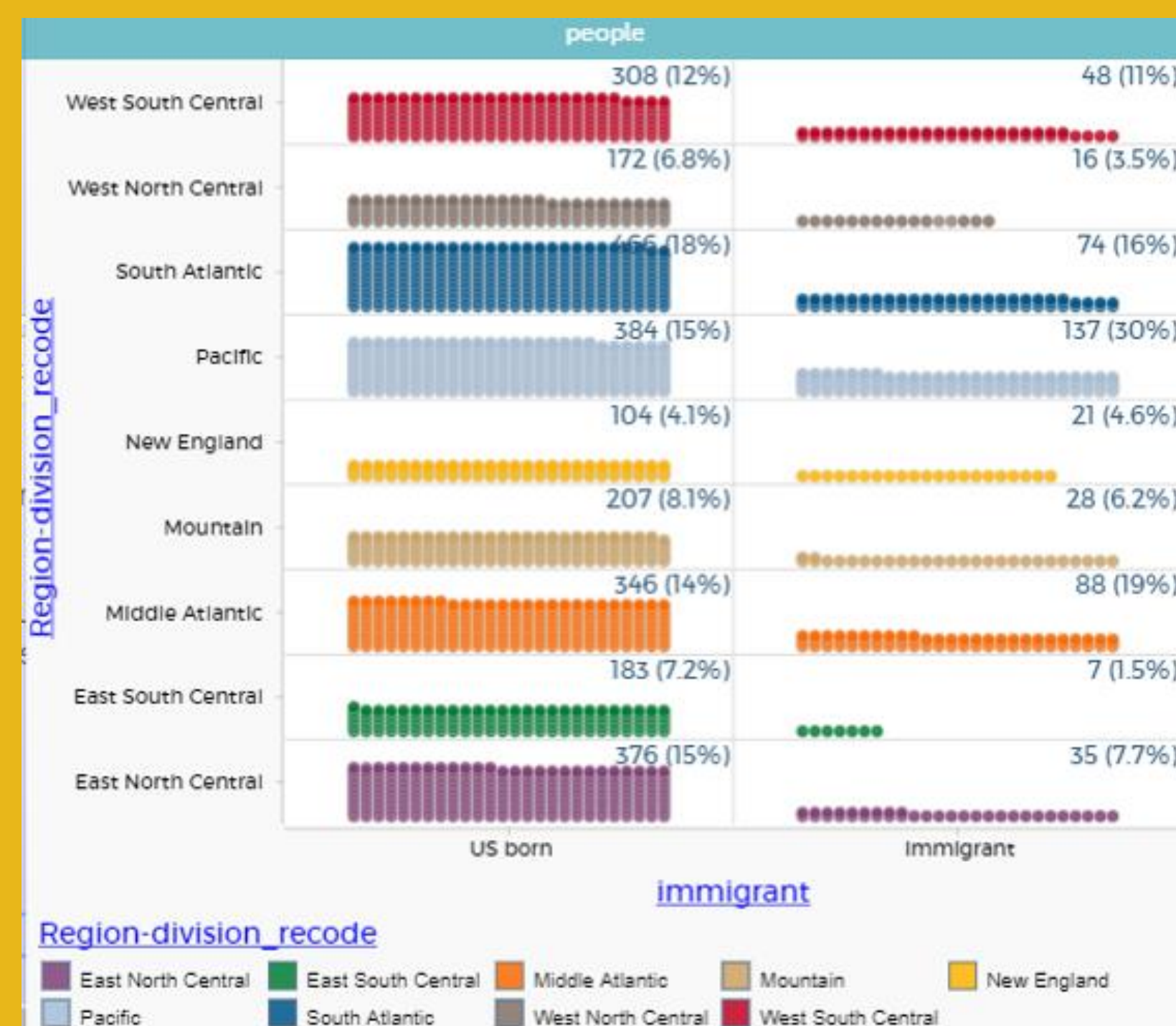
Income Inequality Investigations:

- What is income inequality?
- How do we learn about people's incomes in the U.S.?
- What was the average income in the U.S. in 2017, and how accurately can we estimate it?
- How have middle-income earners in the U.S. been doing over time?
- How have higher- and lower-income earners in the U.S. been doing over time?
- How much income inequality exists between males and females in the U.S.?
- Does education explain the wage gap between males and females?



SDLC Module: Investigating Immigration to the U.S.

This module consists of applied data investigations related to immigration and focuses on describing, comparing, and making sense of categorical variables.



Immigration Investigations:

- Who are immigrants in the U.S.?
- What can we learn about immigration from the American Community Survey (ACS)?
- What percentage of the U.S. population are immigrants?
- Are there more immigrants in the U.S. today than in previous years?
- Where have most immigrants been coming from?
- Where have immigrants settled in the U.S.?
- Are immigrants as likely as the U.S. born to be in the labor force?

Students Build Multivariable Reasoning Skills

As a final project, students apply understanding of the four-step data investigation process and statistical concepts to identify a question, assemble ACS/decennial census data, use graphs and tables to analyze the data, and justify conclusions based on the data. Students examine how the relationship between two variables may change when adjusting for a third variable.

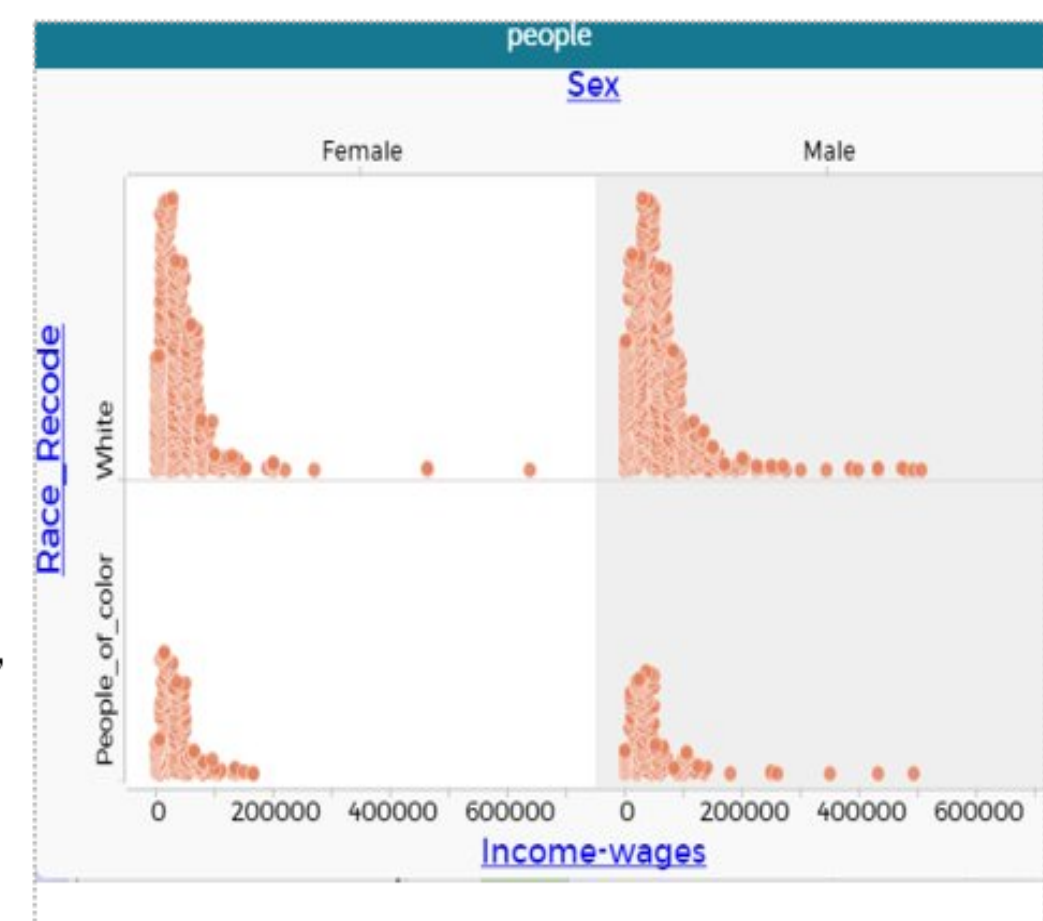
Student Work Samples

Graph Comparing Income-Wages, Race, and Gender

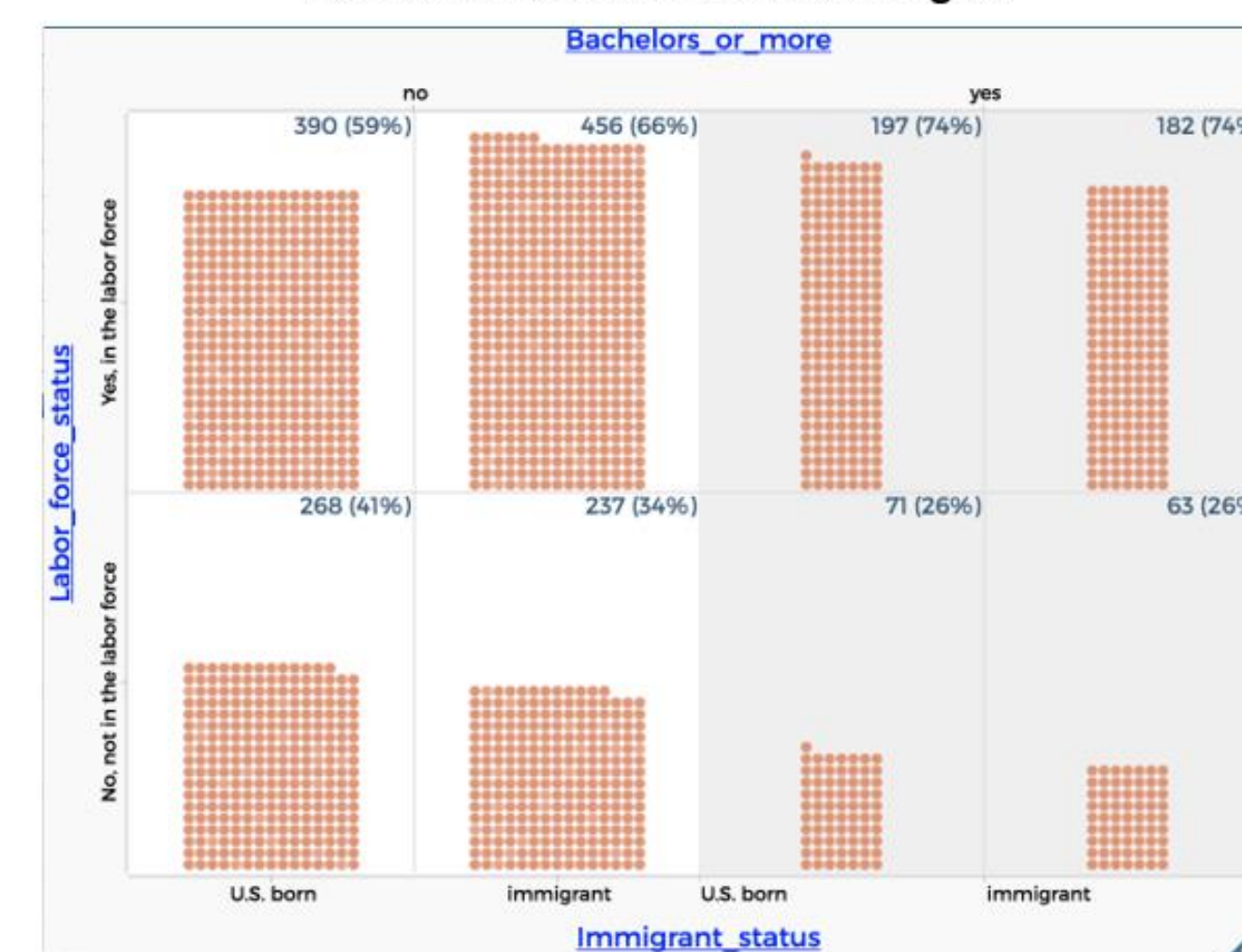
The median income for white females is \$33,000. The median income for white males is \$48,000. This means that for every \$1 a white male makes, a white female will make \$0.69.

The median income for female people of color is \$27,000. The median income for male people of color is \$35,000. This means for every \$1 a white male makes, a female person of color makes \$0.70.

Consider this: If the median income for white males is \$48,000, and the median income for a female person of color is \$27,000, then for every \$1 a white male makes, a female person of color will make \$0.56.



Labor Force Participation Rates of Immigrants and US-Born Individuals with and without a Bachelor's Degree



The claim that "immigrants don't work" is false. Immigrants are in the labor force more than U.S. born. For example, immigrants who are in the labor force are 68% with a 32% not in the work force. For U.S. born, 63% work in the labor force with 37% not in the labor force. That is a 5% difference in labor work. The amount of U.S. born individuals and immigrants who have their bachelors degree is 74% for both and that is good.

Initial Findings

Pre/post findings from Income Inequality beta module, Fall 2019

Growth in Student Interest and Affect

Scales adapted from Linnenbrink-Garcia et al., 2010; Sproesser, Engel & Kuntze, 2016

- Individual interests in statistics and data analysis significantly higher post module ($p < 0.05$, 2-tailed paired *t*-test; $n = 196$; effect size $d = 0.25$)
- Other affective measures grew but not significant at $p < 0.05$

Pre- and post-module interest in statistics and data analysis: Summary of score differences

Scale	<i>n</i>	Pre Mean (SD)	Post Mean (SD)	Post - Pre Mean (SD)	<i>p</i> -value	Cohen's <i>d</i>
Situational interest (8 items)	193	4.96 (0.98)	4.98 (1.05)	0.02 (1.02)	0.799	0.02
Individual interest (4 items)	195	3.82 (1.20)	4.10 (1.24)	0.29 (1.18)	0.001	0.25
Self-concept (5 items)	196	4.70 (1.04)	4.71 (1.06)	0.01 (0.81)	0.986	0.01
Value of content (6 items)	190	4.97 (0.94)	5.07 (0.93)	0.10 (0.84)	0.082	0.12

Note: Scores for each scale were calculated as the average score for items in each scale. Minimum and maximum possible scores for each item and scale were 1.0 and 7.0, respectively.

Growth in Student Learning

Items drawn from the LOCUS (Jacobbe et al., 2014) and CAOS (Garfield et al., 2006)

- Overall score (19 items, $p < 0.0001$), understanding of measures of center (5 items, $p < 0.001$), data representation (4 items, $p < 0.05$), and multivariable thinking (3 items, $p < 0.001$) improved post module
- Other measures improved but not significant at $p < 0.05$

Pre- and post-module understanding of statistics concepts: Summary of score differences

	Pre Mean (SD)	Post Mean (SD)	Post - Pre Mean (SD)	<i>p</i> -value	Cohen's <i>d</i>
Overall (19 items)	9.66 (2.67)	10.94 (3.16)	1.28 (2.99)	<0.0001	0.43
Sampling & Data Collection (3)	1.53 (0.80)	1.57 (0.79)	0.04 (0.92)	0.280	0.04
Data Representation (4)	2.91 (0.91)	3.13 (0.97)	0.22 (1.15)	0.006	0.19
Measures of Center (5)	2.15 (1.08)	2.68 (1.28)	0.53 (1.41)	<0.0001	0.92
Measures of Variability (4)	1.57 (0.91)	1.71 (0.97)	0.13 (1.19)	0.072	0.11
Multivariable thinking (3)	1.50 (0.86)	1.86 (0.89)	0.36 (1.03)	<0.0001	0.35

Note: Items were multiple choice and scored as 1=correct, 0=incorrect or missing. $n = 180$ students.

"It helped me put the pieces together when people say you'll never use this in the real world. This was very helpful to understanding and it made me have a new appreciation for math and especially statistics in general. It just helped me be way more engaged throughout the year, and this was probably the most fun I've had in math in a very long time and the most interesting thing I've done in years." - Grade 12 focus group student

"These two modules, I've seen how effective they are with students. They're challenging, they're engaging, and I think that students want to engage with topics that are real to them, that are important to their community, to their families, to themselves." - Grade 12 teacher