Investigating Income Inequality in the U.S.
Module Overview and Sample Lessons

The *Investigating Income Inequality in the U.S.* module focuses on describing, comparing, and making sense of quantitative variables. Students deepen their understanding of this content by investigating questions such as: How have incomes for higher- and lower-income individuals in the U.S. changed 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?

This module was developed for 12th grade non-AP mathematics and statistics courses and contains seven lessons and one final team data investigation. The module is designed for two to three weeks of instruction.

This sample document contains 1) an overview of the module lessons and learning objectives, 2) the teacher guide for Lesson 6, titled *How much income inequality exists between males and females in the U.S.?*, and 3) the team data investigation.

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Investigating Income Inequality in the U.S.

Lesson Overview and Learning Objectives
Investigating Income Inequality in the U.S. Module

Lesson Overview and Learning Objectives

1. **What is income inequality?**
   The activities in this opening lesson of the module are designed to engage students in the topic of income inequality and to introduce them to the Data Investigation Cycle.

   **Learning Objectives**
   Students will be able to:
   - Pose questions about income inequality and identify which ones can be answered with data.
   - Identify the four steps of the Data Investigation Cycle.

2. **How do we learn about people’s incomes in the U.S.?**
   The activities in this lesson are designed to engage students in exploration of the data source of the module: The U.S. Census Bureau’s American Community Survey. Students will discuss strengths and weaknesses of the data and connect tables and graphs of data from the survey, displayed using CODAP.

   **Learning Objectives**
   Students will be able to:
   - Give a definition of income as measured by the ACS and examples of other ACS variables (attributes).
   - Describe some strengths and weaknesses of an ACS data sample.
   - Describe how the variables (attributes) in a data set relate to the ACS questionnaire.
   - Describe how data in a data table relate to data in a graph.

3. **What was the average income in the U.S. in 2017, and how accurately can we estimate it?**
   In this lesson, students will use sample data from the ACS to estimate the population mean. CODAP will calculate the mean for different samples, and students will consider how increasing the sample size reduces the sample-to-sample variation. The goal is to convince students that a sample of just 1,000 provides a reasonable estimate of the mean of the entire population.

   **Learning Objectives**
   Students will be able to:
   - Graph and describe what the distribution of incomes looked like in the U.S. in 2017.
   - Estimate the average annual income earned from wages for someone in the U.S. in 2017.
   - Explain what sample size can provide a reasonable estimate of the average annual income from wages in the population.

4. **How have middle-income earners in the U.S. been doing over time?**
   In this lesson, students will make some predictions about how average income and the distribution of income has changed in the last 50+ years. Then, they will use CODAP to examine distributions at three points in time, exploring the differences between two measures of center: mean and median. Students will examine how the location of the two measures of center in relation to one another changes based on the skewness of the distribution.

   **Learning Objectives**
   Students will be able to:
   - Describe the difference between the mean and the median of a distribution.
   - Distinguish between typical income and average income.
● Explain how the shape of a distribution influences the location of the mean and median in relation to one another.
● Explain why the median is less influenced by extreme values than the mean.
  Describe how mean and median incomes in the U.S. have changed over time, and provide implications for this pattern.

5. **How have higher- and lower-income earners in the U.S. been doing over time?**
In this lesson, students will examine comparison points at different percentiles to develop the practice of examining the features of an entire distribution. Students will then examine how U.S. incomes at different percentiles have changed over time. This lesson prompts students to think about how they might measure income inequality in the U.S. and to assess its scale using tools that students have reviewed in earlier lessons (such as the mean, median, and percentiles of the income distribution).

**Learning Objectives**
Students will be able to:
● Identify the incomes at different percentiles of the income distribution.
● Describe how higher- and lower-income earners have been doing over time.
● Quantify the variability within the U.S. income distribution using the interquartile range (IQR).
● Describe how measures of center, variability, and shape in the U.S. income distribution have changed over time, and what these changes suggest about income inequality in past decades and today.

6. **How much income inequality exists between males and females in the U.S.?**
This lesson focuses directly on the theme of income inequality between groups and asks students to investigate: Is there income inequality between males and females in the U.S. To explore this question, students will examine the incomes of males and females in a sample of the U.S. population from 2017 to see how they may differ. They will also begin to speculate about what might explain a gap in incomes by sex.

**Learning Objectives**
Students will be able to:
● Compare the mean and median incomes for a sample of males and females in the U.S.
● Compare the variability in incomes for a sample of males and females in the U.S.
● Estimate the difference in typical incomes between males and females.
● Summarize a conclusion in response to a question, supported with clear and accurate evidence, including graphical displays.

7. **Does education explain the wage gap between males and females?**
This lesson continues to explore income inequality among males and females. The data analysis has revealed that typical (median) incomes for males are higher than for females in the U.S. What could help explain this gap? Could differences in education levels between males and females play a role?

The key idea of this lesson is to consider whether introducing a third variable into the analysis can explain or even change the original association between two variables. Students may have encountered this idea previously in terms of “confounding variables,” which are additional variables related to the variables of interest in the study.
Learning Objectives
Students will be able to:

● Describe how a third “confounding” variable may affect the comparison between two variables.
● Analyze the association of two variables across different categories of a third variable.

8. Team Data Investigations
For the team data investigation, students will choose and examine a third variable other than education to see whether the female/male wage gap looks different once we consider this variable. They will also complete all four steps of the Data Investigation Cycle.

Questions for further investigation of income inequality between males and females:

● Could wage disparity between males and females be related to the number of hours or weeks that females work as compared to males? (i.e. Are females more likely to be part-time workers?)
● What does the income gap between males and females look like among people of a particular racial/ethnic background?
● What does the income gap between males and females look like among people in by regions or division of the U.S.?
● What does the income gap between males and females look like among people who have the same or similar occupation or industry?
● What does the income gap between males and females look like among people in a particular age group?
Investigating Income Inequality in the U.S.

Lesson 6 Teacher Guide
Investigating Income Inequality in the U.S.
Lesson 6 Teacher Guide

How much income inequality exists between males and females in the U.S.?

Lesson Overview
This lesson focuses directly on the theme of income inequality between groups and asks students to investigate: Is there income inequality between males and females in the U.S. To explore this question, students will examine the incomes of males and females in a sample of the U.S. population from 2017 to see how they may differ. They will also begin to speculate about what might explain a gap in incomes by sex.

Learning Objectives
Students will be able to:
- Compare the mean and median incomes for a sample of males and females in the U.S.;
- Compare the variability in incomes for a sample of males and females in the U.S.;
- Estimate the difference in typical incomes between males and females; and
- Summarize a conclusion in response to a question, supported with clear and accurate evidence, including graphical displays.

Lesson Introduction and Opening Discussion (5 minutes)
Use Slides to share lesson overview and objectives.

Activity: Investigate the Lesson Question (40 minutes)

Step 1: Ask Questions (and Make Predictions) (7-8 minutes)
The first step in the investigation cycle is to pose a question. In this lesson, the question has already been framed for students, so in this step, students will share some initial ideas. Remind students to explain what information helped inform their answers.

Work with your partner to make some predictions about the incomes of males and females. Record your answers in your shared Google doc for questions #1-3.

Question 1. Who do you think tends to make more money in the U.S., males or females? How much more on average? Provide your best guess, and explain what information has informed your answer.

Question 2. Make a guess about the variability (or spread) of the incomes of males and females. Choose (highlight or underline) from the statements below:
- Males have more variability (or spread) in their incomes than females.
- Females have more variability (or spread) in their incomes than males.
- The variability (or spread) in incomes is about the same for males and female.

Question 3. Briefly explain the reasoning you used to make your guess.
When students have completed their predictions, you can have them share briefly with another team.

**Step 2: Assemble Data Using CODAP (5 minutes)**
This lesson uses the sample of employed individuals of all workers in the U.S. in 2017.

Have students complete the Step 2 question. Let them know to continue on to Step 3: Analyze the data.

- Open the **data set**.

**Question 4.** Write 2-3 sentences to describe the data set including the number of males and females in the data set and overview of what variables (attributes) are included.

**Step 3: Analyze the Data (20 minutes)**
Have students continue on to Step 3.

**A. Compare the centers.**

**Step 3: Analyze the Data**
To describe and compare the incomes of males and females, start with graphs that separate the incomes of males and females, but compare them on the same scale.

- Create a graph with the attribute **Income_wages** on the horizontal axis and **Sex** on the vertical axis.

**Question 5.** Describe the shapes of the income distributions for males and females. Be sure to note the ways they are similar and different.

Next, we want to use a measure of center to compare incomes for males and females in the U.S. in 2017. Use the **Ruler** to check the **Mean** and **Median** boxes. This will add the lines to each graph.

**Compare the centers.**

**Question 6.** Report the means for the means and females. Compute the difference between the mean income for males and females and write a sentence to summarize the comparison.

Male mean: $\text{60,008}$  
Female mean: $\text{41,466}$  
Difference: $\text{18,542}$

**Question 7.** Report the medians for the means and females. Compute the difference between the median income for males and females and write a sentence to summarize the comparison.

Male median: $\text{38,000}$  
Female median: $\text{30,000}$  
Difference: $\text{8,000}$

**Question 8.** Another way to compare these values is by computing the ratio.
Calculate the ratio of female mean income to male mean income and complete the sentence below:

For every dollar that a male makes, on average, a female makes $ \underline{0.69} \underline{0}. \\

Hint: Express this ratio as $\frac{\text{mean female income}}{\text{mean male income}}$ as a decimal to determine what a female earns compared to one dollar earned by a male.

**Question 9.** Calculate the ratio of female median income to male median income and complete the sentence below:

For every dollar that a male makes (typically), a female makes $ \underline{0.78} \underline{0}$. \\

Hint: Express this ratio as $\frac{\text{median female income}}{\text{median male income}}$ as a decimal to determine what a female earns compared to one dollar earned by a male.

Questions for Discussion:

- What did you learn about the mean incomes of females as compared to males?
- What did you learn about the median incomes of females as compared to males?
- How did you calculate to determine how much money a female earns for each dollar a male makes?
- What does it say to you that there is more disparity when you compare the mean incomes?

**B. Compare the variability.**

Next, you will investigate the variability of male and female incomes by determining the Interquartile Range (IQR) for each group. Have students complete questions 10 and 11.
Compare the variability.

- Use the Ruler to select the Boxplot. This will add a boxplot to each graph. If you hover over the ends of the boxes, you will find the 75th percentile (or “upper quartile” which CODAP labels “Q3”) and the lower 25th percentile (“lower quartile”, “Q1”).

**Question 10.** Find these values for the males and females. Use these values to compute the interquartile range (Q3 – Q1).

<table>
<thead>
<tr>
<th></th>
<th>Males Q3</th>
<th>Males Q1</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Males</td>
<td>$70,000</td>
<td>$20,000</td>
<td>$50,000</td>
</tr>
<tr>
<td>Females</td>
<td>$52,000</td>
<td>$12,000</td>
<td>$40,000</td>
</tr>
</tbody>
</table>

**Question 11.** According to the interquartile range, which group (males or females) appears to have more variability in their income-wages? *Males have a higher IQR and more variability in their income-wages.*

*Pause here for class discussion about the chart.*

Have students share their calculations in Question 10 and response to Question 11. Then direct students to complete Step 4: Summarize Conclusions

**Step 4: Summarize Conclusions (7-8 minutes)**

Summarize what you have learned about how the income distributions compare for males and females. In particular, use information from your answers in Step 3 to answer the following questions.

**Question 12.** Who tends to make more money in the U.S.: males or females? How much more? (Be sure to say whether you are comparing the means or medians and describe your calculations.)

**Question 13.** Use evidence (including graphs and calculations from Step 3) and reasoning to summarize and explain your conclusions.

**Question 14.** Describe how your findings compare to your initial guess in Step 1.

**Lesson Wrap-Up (10 minutes)**

Summarize key learning by revisiting the lesson learning objectives with students. Focus on a couple of the lesson objectives and invite students to share their ideas and examples.
Final Activity: Exit Task (5 minutes)
Have students complete the exit task individually.

Exit Task
A final part of Step 4 of the data investigation cycle is to consider what new questions have arisen as a result of your data analysis. Here is a new question for you to answer.

Question 1. What might explain differences in income-wages and differences in income variability between males and females? Suggest at least 1-2 reasons for each and describe how you think they might impact income.

Income wages:
Income variability:

Extension Question. Examine the graph of Earnings and Projections shown below. What do you notice? What do you wonder?
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Team Data Investigation
Team Data Investigation: Investigating Income Inequality in the U.S.

Overview
Apply your understanding of the 4-Step Data Investigation Cycle and statistical concepts by implementing the process for a new question using 2017 ACS income data. You will choose a question, assemble a data set, analyze the data and draw conclusions. You will share your work and findings with your peers.

Step 1: Ask a Question
1. Using the USS codebook, the ACS questionnaire, and the questions listed below, identify a third attribute that you think is related to income-wages and perhaps to differences in income between sexes. You will work together with your partner or team to explore:
   - The distribution of the third attribute
   - How this attribute is related to income-wages
   - Whether or not the female/male wage gap looks different once we consider this attribute

Sample Questions for further investigation of income inequality between males and females:
   - Could wage disparity between males and females be related to the number of hours or weeks that females work as compared to males? (i.e. Are females more likely to be part-time workers?)
   - What does the income gap between males and females look like among people of a particular racial/ethnic background?
   - What does the income gap between males and females look like among people in by different regions of the U.S.?
   - What does the income gap between males and females look like among people in a particular age group?
   - What does the income gap between males and females look like when you look only at those males and females based on whether or not they have children?
   - What does the income gap between males and females look like when you look only at those males and females based on whether or not they have ever been married?

2. Why did you choose this third attribute? Why do you find it of interest? What are you curious about?
3. Hypothesize about the third attribute. Make a prediction about whether the income-wages gap between males and females is any different when you consider this third variable.
Step 2: Assemble Data

1. Use the USS Data Portal to create a data set of 3000 cases that you will use to investigate your question. (In the data portal you can get 1000 cases at a time. Select Keep existing data to get 1000 cases two more times.) List the variables (attributes) that you will include in your data set.
2. Create a graph of this attribute and describe the nature of this new variable (e.g., what are the categories, what do the categories mean?) Note: You can grab a category to move it/reorder the categories in the graph.
3. Do you want to remove any categories? If so, do so and document your steps. Be sure to save this graph and give it a descriptive title (Graph1: title).
4. Before you begin your analysis, be sure to include only those individuals in your data set who are employed. Document your steps so you can report them in your presentation. Remember to Set Aside cases in the data window, rather than hiding the cases in the graph.
5. Write a brief description of your data assembly process, including how you chose your attributes and cleaned your data set. Also discuss any limitations to your data set.

Step 3: Analyze Data

1. Using CODAP, produce a graph exploring the relationship between income-wages and your new attribute
2. Save this as Graph2-[Title]. Compare the distributions of income-wages (Hint: You should compare shapes, centers, and spreads aka variability) across the categories of your new attribute with appropriate numerical support.
3. Using CODAP, produce a graph saved as Graph3-[Title] that explores the male/female income-wage distributions (sex on vertical and income-wages on horizontal).* Now add the new attribute (e.g., along the top or right side) and the means, medians, and box plots. Compare the male/female wage age within each category of the new attribute.
4. What story do you think is told by the graphs?
5. What could help explain the relationships you see among variables or other patterns in the data? How might you explore possible explanations?

Step 4: Summarize Conclusions

- Summarize what you learned about how the new attribute is related to income-wages.
- Summarize what you learned about how the male/female wage gap changes across the categories of the new attribute. Would you say the male/female wage gap increases or decreases or stays the same across these categories?
- Pose at least one new question for future investigation.
- Create a short slideshow or report of your investigation to present in a small group. Your presentation should include the slides described below. You are welcome to include additional slides as needed.
- Prepare a short presentation using your slides that you will present to another team.

For Graph 2, include on your slide summary sentences of what the graph reveals about the distribution of income-wage for each category of the third attribute. Include statements about the center, shape, and variability of each distribution.

For Graph 3, include a description of what the gender gap in income-wages looks like for each category of the third attribute. Cite some numbers from your analysis to indicate how much the male-female gap in income-wages changes across categories of the third attribute.