Social Justice Drives Students Deeper: A Statistics Lesson on Wealth Impacting Quality of Life

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Abstract: *This article communicates the value in teaching for social justice in a mathematics classroom. A lesson is provided with the intent of empowering students to reach statistically sound conclusions that hold weight and change their perspectives through the vehicle of social justice. The lesson involves students investigating whether wealth has an impact on quality of life. We, as teachers, don't need to keep trying to make our students care about statistical concepts, their craving for justice will do that for us if we let them tap into it through real, compelling data.*

Keywords. *Social justice, statistics*

1 Introduction

Justice is ingrained in us. Our students want justice in this world just as much as we, their teachers, do. They are faced with injustice daily. Issues in our society and our hallways matter to our learners. Thus, why not ride these waves of engagement in our classrooms? Yes, even in a mathematics course. In particular, statistics has the power to reveal understanding and conclusions to our students in ways that our lectures cannot. For example, I can say to my students, "Some people claim that black people have a greater chance of ending up on death row than white people." However, until real data is examined on individuals that occupy death row, my statement has little to no value. Analyzing data also challenges students to become critical thinkers that can justify their conclusions using statistical concepts. Let's stop forcing our students to use concepts they don't care about to reach conclusions they don't care about. Let's empower them to reach statistically sound conclusions that hold weight and change their perspectives through the vehicle of social justice.

2 The GAISE Report

Teaching with this foundational mindset can set our students up to reach the highest levels of understanding in the *Guidelines for Assessment and Instruction in Statistics Education* (GAISE) Report. Students will successfully reach levels B and C on the GAISE framework as they formulate questions not restricted to the classroom, pose their own questions of interest, compare group to group displays

of data, use distributions in analysis as a global concept, note the difference between two groups with different conditions, and look past the data. The lesson ahead is an approach that addresses key statistical concepts and reasoning in students' problem solving processes that is based on real data and real-world contexts (Franklin 2007).

3 A Lesson Idea

When venturing into the deep sea of social justice issues, poverty and wealth are likely to arise. This particular topic for my lesson was inspired by an article called "Poverty and World Wealth" by Susan Hersh and Bob Peterson in *Rethinking Schools* magazine (Hersh 2004). To incorporate this loaded topic into my classroom, I first constructed a lesson that would compare a variable related to poverty to a variable related to wealth. Students were originally using interesting technology to determine if poverty impacts wealth in a country. While that sounds cute and all, it was dry. If I'm going to spend instructional time having my students collect and analyze data on topics that matter in our world, it better be more helpful than a worksheet with pre-collected data on it. Thus, I went back to the drawing board.

Poverty is an issue. Many people are born into it and never find their way out. Data on it should pump blood faster through my students' veins. How can I humanize this data? How can I let them really sit in it? There must be a hook.

3.1 A Captivating Hook

The best introductory activity I found was in a chapter of *Rethinking Mathematics: Teaching Social Justice by the Numbers* called "Ten Chairs of Inequality" by Polly Kellogg. It's the jaw-dropping kind that leads to students amped and ready to go before you can finish explaining directions. Ten students and ten chairs are needed. Each student represents 10% of the US population, while each chair represents 10% of the US wealth. It's most fun to first have the ten students reason together and sit on the chairs according to what they think the wealth distribution in our country looks like. For example, one student sitting across two chairs would mean that 10% of the US population makes up 20% of the US wealth. Then, students are informed that only one of them takes up 70% of the wealth. Thus, a student must lay across seven chairs, while another person occupies only one chair, the last two chairs are each stacked with three people on them, and the remaining two people represent the 20% of our nation that is in debt. Therefore, the last two people have nowhere to sit. A visual of what will occur in this activity is provided in Figure 1.
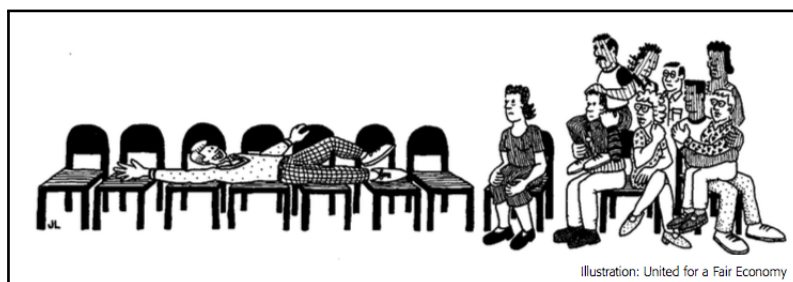

Fig. 1: *Students engaged in the "ten chairs of inequality" activity (Gutstein, 2006)*

3.2 Motivating Conversation

The visual is powerful and the conversation that follows even more so. This activity sparked many questions about what is fair and unfair, just and unjust. Discussions and arguments regarding whether or not the quality of life is affected by this unequal distribution of wealth happened naturally. Perhaps, then, it would be more interesting to look at data on wealth versus quality of life. Yet, there must be a way to zoom in closer. I wanted this lesson to hit closer to home than foreign countries - although that piece will be useful later, especially for students that have rich history in places outside of the US. In an effort to strike a chord that students will respond to, we must go local.

3.3 Phase One

What if we could have students address the question: "Does wealth have an impact on quality of schools?" Data and an activity on Ohio school districts measures of wealth and performance index is provided in a worksheet listed at the end of this paper. We will call this activity phase one. Students get the freedom to compare performance index in schools to a measure of wealth of their choice: expenditures per student, poverty rate, median household income, or median house/condo value. Data was collected from `education.ohio.gov`, `city-data.com`, and `cleveland.com` to design this activity. Students are asked to create a scatter plot of the data they choose and describe the trend in detail. They are also given the freedom to exclude outliers as long as their choices are justified. A summary of students' conclusions from their data is to be defended on the worksheet as well as in front of the class if the teacher so deems appropriate. Students, whether individually or in groups for this activity, should be confident in answering the question of whether or not wealth impacts quality of schools. The beauty of statistical analysis is that students may reach various different conclusions as a result of reasoning through their data successfully. After students have sifted through data on school districts near them they've wondered about, the hope is that they would be ready for a less structured activity and a chance to ask a similar question from a worldview.

3.4 Phase Two

Onto phase two! Students will select a country and compare poverty/wealth to the quality of life and describe the data using statistics. I've been particularly impressed by the visual representation and variable choices that Gapminder.org provides for users to freely analyze. Thus, Gapminder (`gapminder.org`) it is! To have consistency and convenience of comparing data from country to country as a class, phase two begins with variables chosen for students. Income per person and life expectancy are first examined in their selected country. After screenshots are provided and the trend is described, students are asked to formulate a question regarding the history of their country. For example, a dip in life expectancy around 1918 in Guatemala could lead students to wonder: "What happened in 1918 that may have caused this decrease in Guatemala's life expectancy?" This is an excellent part in the lesson as a partnership of statistics and social studies emerges in the midst of our investigation - cross-curricular, interdisciplinary beauty!

Next, a boxplot is requested of the countries' income per person data. Yes, I'm with you - I hate limiting students to a specific mathematical model. However, it serves a purpose and more freedom in modeling is soon to come! There is something powerful about seeing all of the selected countries represented together on the same scale. Have students draw their boxplots on the board or submit them electronically for you to project on a screen. It brings up great discussion before they head into the last part of phase two. The last piece created for students involves more freedom within exploring the same country. They are asked to compare two variables from Gapminder, one variable must be related to poverty/wealth and one must be related to the quality of life. Students

provide a screenshot of their results on Gapminder and create a visual representation of their choice. Based on trends of the data, students will draw specific conclusions regarding the impact (or lack thereof) of wealth/poverty on the quality of life (or vice versa). Conclusions must be justified using their data. Finally, they are again asked to formulate a question from the data about the country's history, but this time they explore possibilities of possible answers. Students may use the internet and cite sources to complete this part of the activity. This last part of the lesson was especially intriguing.

4 Differentiation

To set the stage for differentiation, there is very little instructional time in this lesson. Plenty of space is provided for the teacher to facilitate, assist, and modify as needed. Also, not all parts of this activity are necessary for student growth in data analysis and furthered understanding of the impact of poverty and wealth in our world. Thus, teachers may choose to exclude various parts of the lesson for students that may have trouble navigating all of it successfully. The lesson and materials provided will likely span over two days in a mathematics class. To ensure that students who work quickly and efficiently have enough to work with, specific parts (such as the second part of phase two, the Gapminder activity) could be excluded or marked as optional for students.

5 Conclusion

Statistical analysis is simply not going to pump up my freshmen. If student engagement and deep understanding is a goal of ours, having students fill out a worksheet on the trend of a random scatter plot is dangerous approach. Let's stop setting up our students to give bare-minimum, empty answers when analyzing data. Let's put flesh on the values they look at in our classroom and give them something meaningful to think through. If it is possible for them to end our course with a mature approach on our world's social justice issues, why not provide that opportunity? We don't need to keep trying to make our students care about statistical concepts, their craving for justice will do that for us if we let them tap into it through real, compelling data.

6 MATERIALS

- Paper & writing utensils
- Ten chairs
- Access to computer/internet for Gapminder (`gapminder.org`)
- A form of technology that is regression enabled
- Worksheets for Phase I and Phase II (provided at end of this document)

References

Franklin, C. A. (2007). *Guidelines for Assessment and Instruction in Statistics Education (GAISE) Report: A Pre-K–12 Curriculum Framework*. Alexandria, VA: American Statistical Association.

Gutstein, E., & Peterson, B. (2006). *Rethinking Mathematics: Teaching Social Justice by the Numbers*. Milwaukee, WI: Rethinking Schools.

Hersh, S., & Peterson, B. (2004). Poverty and World Wealth. *Rethinking Schools*. Retrieved from `http://www.rethinkingschools.org/publication/rg/RGPoverty.shtml`

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Phase 1   Name: _____

Big Question: Does wealth have an impact on quality of schools?

For today's activity, your team will use statistics to investigate whether there is a relationship between a measure of wealth (options listed below) and the quality of nearby school districts. We will use *Performance Index* (PI) as the indicator of the quality of a school district.

Performance Index:

● http://www.cleveland.com/datacentral/index.ssf/2014/09/ohio_school_district_performan.html

Measures of Wealth (choose one):

● Expenditures per Student: http://education.ohio.gov/lists_and_rankings
● Poverty Rate: www.city-data.com
● Median Household Income: www.city-data.com
● Median House/Condo Value: www.city-data.com

Your team is responsible for the following:

1. Enter data for each district into the data table provided.
2. Make a scatterplot comparing [Measure of Wealth] to [Performance Index] across school districts. Each school district should be represented by a data point.
3. Describe the trends of the data:
    a. What kind of association? (Linear, curved, neither)
    b. What direction is the association? (Positive, negative, neither)
    c. How strong is the association? And how do you know?
4. Prepare a short summary to present to class, using conclusions from your data to defend whether there is a relationship between [Measure of Wealth] and [Performance Index].

1. **Complete the data table below.**

District	Measure of Wealth (write it below)	Performance Index

2. **Insert screenshot of scatterplot below. Include labels. If there are outliers, consider whether or not they should be included.**

3. Describe the trends of the data (see questions above). Discuss any outliers.

4. What relationship(s) do you observe in your data? Describe the relationship(s) and use conclusions from your data to defend your answer.

Name: _____   Date: _____

Poverty & World Wealth

Objective: To compare poverty/wealth to the quality of life and describe the data using statistics.
Please type your responses in blue font.

Part I:
- **Click here** to access Gapminder.
- **Select a country** of interest to you from the list on the right.
- **Press Play** below the x-axis to watch how the wealth/poverty changes in chosen country over time.
- **Provide screenshots** of your country's data below.
- Please note: The link will take you to a graph with variables "Income per person..." vs "Time." After you've studied this data and taken a screenshot, change the y-axis to "Life Expectancy (years)."

Your Country of Choice: _____	
Screenshot of " Income per person... " vs "Time"	Screenshot of "Life Expectancy (years)" vs "Time"

1. What do you notice about the trends of this data in both of the above graphs?

2. Come up with a question regarding the history of this country based on something that struck you in your data.

3. Create a boxplot for "Income per Person... " vs "Time" using the most recent 15 data points. Please copy and paste your results in the table provided. [Click here](#) for the box plot generator.

"Income per Person" vs "Time"

4. Describe the data for the income share of " Income per Person... " vs "Time" using your above graphs.

5. Put your boxplots on the board to compare to the rest of your classmates' countries using same scale.

Part II:

For the same country in Part I, investigate data given by a different x-variable that interests you and is related to poverty/wealth as well as a different y-variable that is related to quality of life.

Your Country of Choice: _____
(Same as Part 1)
Screenshot of "_____" vs "_____"   (one variable must be related to poverty/wealth and one must be related to quality of life)

1. Create a visual representation of the data you found via Gapminder and display it below:

2. What do you notice about the trends of this data? Be sure to draw conclusions that are justified by your data.

3. Come up with a question regarding the history of this country based on something that struck you in your data.

4. Explore possible reasons that could explain your proposed question and elaborate on them below.