Specious Solutions: How a Lack of Fastidious Thinking Leads to the Oversimplification of Complex Problems

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I have mulled over the following paragraph from Capper and Young (2015) since I first came across it in the readings.

> Because proportional representation anchors the equity audit (as discussed above), the equity audit form requires that data collection include fractions along with percentages to be able to measure proportional representation. For example, of 100 students labeled with disabilities, if 70 of these students receive free and reduced-priced lunch, then the fraction for this data is 70/100 and the percent is 70%. This data can then be compared to the percent of students in the school who are receiving free and reduced-price lunch, which in this example is 210 students out of 600 (210/600 = 35%). Thus, in this example, at this school, we know that students from low-income homes are twice as likely to be labeled for special education, and thus are over-represented in special education. Proportional representation of students from low-income homes in special education should be 35% or less. (p. 194)

The intent behind this line of thought is deceitfully attractive. Indeed, educators should be identifying equity gaps and implementing solutions. Yet, the conclusions drawn from the data strike me as erroneous. To paraphrase Casey Gerald (2018), I was real cracked up by it. So I will try to trace those cracks with words.

Complexities of Proportional Representation

The authors postulate that proportional representation (PR) is the cornerstone of an equity audit. In their defense, the idea that the demographics of a school should be reflected across all facets of the curriculum feels right. It is a beautiful, simple idea reminiscent of the foundations of our democracy. But, PR is a complex issue. Tollefson and Magdaleno (2016) describe the acknowledgment gap as the failure of educational leaders to interrogate their assumptions about students and families. I propose that Capper and Young (2015) have fallen into a solution gap. That is, they have failed to interrogate the specious logic of their proposed solution.

First, consider their response to equity data showing that Latinos may be underrepresented in special education (SPED). “The question then, under the principle of proportional representation, is should more Latino students be labeled for special education? The answer is no. When typically marginalized students are under-represented in school remedial systems… that is a good thing” (Capper & Young, 2015, p. 192). The problem with this response is that PR is what mathematicians refer to as a zero-sum game. In a zero-sum game, an advantage or disadvantage to one player is exactly balanced by the opposite for the other player. In the case of PR, an underrepresentation of one population in remedial systems must be accompanied by an overrepresentation of another population. This is because both populations share a common denominator. If the authors are going to claim that PR is the anchor of the equity audit, they cannot tout the aspects that are appealing while choosing to ignore the rest.

A second concern is the feasibility of implementation. The master schedule of a school is influenced by a multitude of factors: teacher credentials, elective choices, federal requirements for SPED, support for English language learners, class size, etc. In some cases having an exact PR, while mathematically possible, may result in unfavorable scenarios. For a concrete example, consider De Anza Academy of Technology and the Arts (DATA). For the 2018-2019 school year, DATA had 21 Asian students out of 839 total students or (21/839 = 2.5%) (California Department of Education, 2020). They had an average class size of 29 students in math. Placing just one Asian student in an average math class accounts for 3.4% enrollment. In order to meet the requirements of PR outlined in the Capper and Young (2015) paragraph above, DATA would have to have a class size of at least 40 students in every class that contained one Asian student. If there were two Asian students placed in the same class, DATA would need a class size of at least 80 to achieve PR.

A third concern is that there seems to be a fundamental misunderstanding of independence vs dependence of variables. Variables are considered independent when they have no impact on each other. Consider flipping a fair coin. Each flip is independent because prior flips have no impact on future flips. Even if the coin has landed heads ten times in a row, the next flip still has a 50/50 chance of landing heads again.

If this is the case, notwithstanding the issues previously described, then Capper and Young may have a point. According to the law of large numbers, if SPED and low-income are independent events, and if those variables are randomly and uniformly distributed, and if we could look at an infinite school population, then the portion of low-income students and SPED would approach their respective ratios with probability one. It is important to note the law of large numbers is paradoxical in nature. While over a large enough sample size the ratios of students labeled SPED and low-income will approach their given likelihood, there is no guarantee for some finite population. In fact, the probability of having an exact PR in a population of 600 is extremely unlikely.

Utilizing the example provided by the authors, I constructed a program using Python that runs a probability simulation (see Appendix A). In each trial, the program randomly distributes the variables low-income ($p=0.35$) and SPED ($p=0.166\ldots$) across a population of 600 students. The program then tracks the portion of students labeled SPED, low-income, and both. This is then iterated over a given number of trials. In optimal conditions, the probability of having a PR of low-income students in SPED within 2% is only around 18% after 100,000 trials. The probability that there is an exact PR of low-income students in SPED is less than 1% after 100,000 trials.

Evidence shows, however, that low-income and SPED are not independent. Burke et al. (2011) found that students with an Adverse Childhood Experiences (ACE) score of zero exhibit behavioral/learning disabilities around 3%. However, with an ACE score between one and three, the percentage of students exhibiting behavioral/learning disabilities jumps to about 20%. For students with an ACE score of four or more that figure becomes approximately 51%. Furthermore, Bruner (2017) found that poverty was strongly correlated with a positive ACE score. Considering that there is a minimum three-fold increase in behavioral/learning problems associated with a positive ACE score and that children living in poverty are more likely to have a positive ACE score, then we should expect the rate at which low-income students are labeled as SPED to be disproportionate to their portion of the total population. A disproportionate representation does not necessarily mean the school is engaging in inequitable practices; rather, it is potentially a byproduct of the dependence of behavioral/learning disabilities and low-income.

Unintended Consequences

PR is an incredibly complex problem beyond the scope of education as well, often with unintended and unpredictable consequences. Consider political Gerrymandering as an analog. Gerrymandering is the process of drawing redistricting lines in such a way to help one political party over another. At their hearts, both PR in schools and Gerrymandering are partitioning problems. In her appearance on *The Joy of X* podcast, mathematician Moon Duchin discusses her work regarding Gerrymandering (Strogatz, 2020). She shares two stories that are particularly relevant to PR in the educational sense.

The United States House of Representatives is designed to be proportionally representative based on the population of the states that constitute the union. In the case of Massachusetts (MA), the state is broken down into nine districts, and the state sends nine representatives to the House every two years. Although one-third of the vote in MA goes to Republicans, MA has not sent a Republican Representative to the House since 1994. While, based on the vote, you would expect 8 of the 24 (8/24 = 1/3 = 33.3%) representatives chosen between 1994-2018 to be Republicans, there were zero. Clearly, this is a prime suspect for a Gerrymandering investigation. Duchin and her team were able to prove mathematically that the lack of Republicans from MA in the House was not a result of partisan Gerrymandering. Rather, it was a result of the Republican vote having a uniform distribution across the districts. Republicans won one-third of the vote in every district, every precinct, every town, resulting in the inability to win anywhere. To reframe this in terms of Capper and Young's argument, precisely because Republicans had PR at every local level of the election, they ended up with no representation in Washington DC.

The second story Duchin shared was that of Pennsylvania. In 2011, Republicans gained control over drawing redistricting lines. The resulting map was so disfigured a case was brought to the state supreme court which threw it out as illegal partisan Gerrymandering (see Appendix B). The map was redrawn with more typical looking districts and approved by the court (see Appendix C). Subsequently, when Duchin and her team analyzed the new map, they found it was a statistical outlier. The new map behaved like the original, resulting in a similar partisan advantage. While the court had solved the superficial, aesthetic problems with the maps, the underlying inequalities remained.

Grogan and Shamini (2015) offer a similar oversimplification of a complicated issue. "If there are no gender differences in test performance, the absence of women from STEM majors *can only* [emphasis added] be attributed to lack of encouragement and/or hostile classroom experiences in high school and college" (p. 128). That is a bold claim. Though Alber (2017) seems to support this claim describing schools as distributing time, energy attention, all in favor of male students, Semuels (2017) describes how girls from low-income homes are leaving their male counterparts behind.

Zölitz & Feld (2018) found that when female students have more female peers, they tend to choose majors that are typically female-dominated, e.g., humanities. At the same time, males who have more female peers tend to choose majors that are typically male-dominated, e.g., math or engineering. The authors posit that the fact that the portion of female students attending university has increased dramatically since the 1950's itself has exacerbated the disproportionate representation of males in fields such as STEM. In other words, by addressing the issue of PR of women attending university overall, potentially, there was a negative impact on the PR of women in STEM majors.

A Modest Proposal

Inequitable practices, such as funding schools through property taxes, fuel the disparity in quality between white students and students of color (Sumner, 2015). Coupling this idea with the findings of Bruner (2017) and Burke et al. (2011) that poverty, race, and ACE are correlated, trying to artificially adjust the PR of students in schools serves as a specious solution. Much like the case of the redistricting lines in Pennsylvania, solely focusing on PR results in educational leaders cleaning up the aesthetics without addressing the root cause.

Instead, educational leaders searching for solutions within the current system should expand the definition of learning disabilities. All students who live in poverty should have an individual educational program (IEP) and, consequently, be labeled as SPED. The reason for this is two-fold. First, with SPED services comes additional federal funding that can help alleviate the disparity in funding due to property tax. In the case of Ventura Unified, general education classes are funded with a student to teacher ratio of 34:1. However, resource classrooms that serve students with IEPs are funded at 28:1, and special day classes are funded at 18:1. Expanding the definition of learning disabilities to include poverty could, therefore, be parlayed into smaller class sizes. Second, students with an IEP become eligible for services such as individual counseling, family counseling, social-emotional support groups, and classroom accommodations.

In a Lecture at the University of California Santa Barbara, Dr. Nadine Burke Harris (2018) offers five strategies to help counteract the effects of a positive ACE score. Two of those included developing healthy relationships – particularly through multigenerational counseling – and mindfulness practices. These are the specific services that can be offered with an IEP.

Victor Rios (2015) tells us that students like him are like oysters. They will not open up until they are ready. If someone is not there they will close back up. Running classes of 40 students to one teacher in order to achieve PR makes being available for support at an individual level nearly impossible. What students need is true equity. Educational leaders should strive to meet those needs, not create the facade of equitable proportions.

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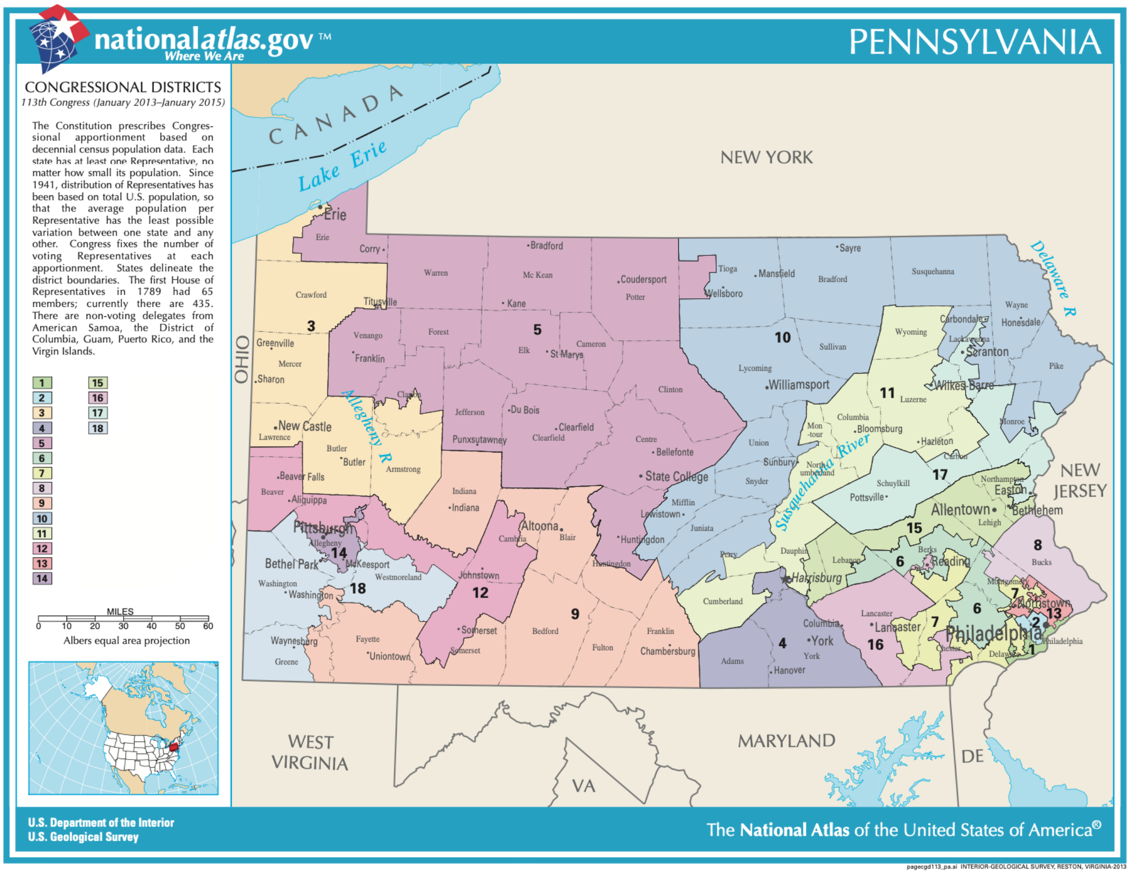
Appendix A: Sped and Low-income Probability Simulation in Python

```
import numpy as np
import random

n = 1
p_sped = (1/6)
p_lowin = (7/20)

runs = 100000
pop = 600

PR_exact = 0
PR_twoper = 0
for i in range(runs):
    sped = 0
    lowin = 0
    both = 0
    sample_school = []
    for s in range(pop):
        student = str(np.random.binomial(n,p_sped)) + str(np.random.binomial(n,p_lowin))
        if int(student) == 10:
            sped += 1
        elif int(student) == 1:
            lowin += 1
        elif int(student) == 11:
            both += 1
        sample_school.append(student)
    per_lowsped = both/(sped + both)
    per_lowpop = (lowin+both)/(pop)
    if 0<(per_lowsped-per_lowpop)<= 0.02:
        PR_twoper += 1
    elif per_lowsped==per_lowpop:
        PR_exact +=1

prob_PR_exact = (PR_exact/runs)*100
prob_PR_twoper = (PR_twoper/runs)*100
print('The probability of having exact proportional representation in ' +str(runs) + ' trials is: '
      + str(prob_PR_exact) + '%')
print('The probability of having proportional representation within 2% in ' +str(runs) + ' trials is: '
      + str(prob_PR_twoper) + '%')
```

```
The probability of having exact proportional representation in 100000 trials is: 0.158%
The probability of having proportional representation within 2% in 100000 trials is: 17.589%
```

Appendix B: Gerrymandered Map Disregarded by the PA Supreme Court



Appendix C: Redrawn Map Submitted to PA Supreme Court