



For CAMI meeting May 6, 2019 - Community of Adult Math Instructors, NYC

## Developing understanding of civic statistics and statistical literacy

Iddo Gal ©  
U. of Haifa, Israel  
iddo@research.haifa.ac.il

Jim Ridgway ©  
Durham U., UK  
jim.ridgway@durham.ac.uk

James Nicholson ©  
Durham U., UK  
j.r.nicholson@durham.ac.uk

### 1. Background - about ProCivicStat:

This booklet and workshop are products of ProCivicStat (PCS), a partnership of the Universities of Durham (UK), Haifa (Israel), Ludwigsburg (Germany), Paderborn (Germany), Porto (Portugal), Szeged (Hungary). PCS has been funded by the ERASMUS+ program of the European Commission.

**What are *Civic Statistics*?** These are findings, data, and statistical messages about important or "burning" societal and economic issues (e.g., crime, employment, income, pollution, education, equality, social change, health, accessibility to services, social exclusion, and many others). Civic statistics involve many concepts or ideas *not* commonly covered in introductory statistics courses.

ProCivicStat believes that, to equip (young) adults to face the challenges of an increasingly data-rich world and engage statistical and quantitative evidence about society, current curricula and teaching methods should be revisited, so as to better promote statistical literacy. To that end, PCS has created a ***Call for Action Report***, and integrated resources including conceptual frameworks, datasets, visualization guides, lesson plans, workshops and other guidelines.

**For more details and resources see the ProCivicStat website:** <http://iase-web.org/islp/pcs/>

**Acknowledgment:** We thank the ERASMUS+ program for its support. However, the opinions expressed in this workshop reflect the authors' own views and not necessarily those of the sponsoring agency

### Contents:

Opening, background, needs
Activity 1: Warm-up, statistics and context
Activity 2: Population projections
Activity 3: Gender pay gap
Activity 4: Poverty + Risk of Poverty
ProCivicStat recommendations, and conceptual frameworks
How to implement civic statistics, beyond Stat 101 More resources, see <i>CivicStatMap</i> tool - on PCS website

**Activity 1:** Read tasks A/B/C, which may be given as class or home assignments.

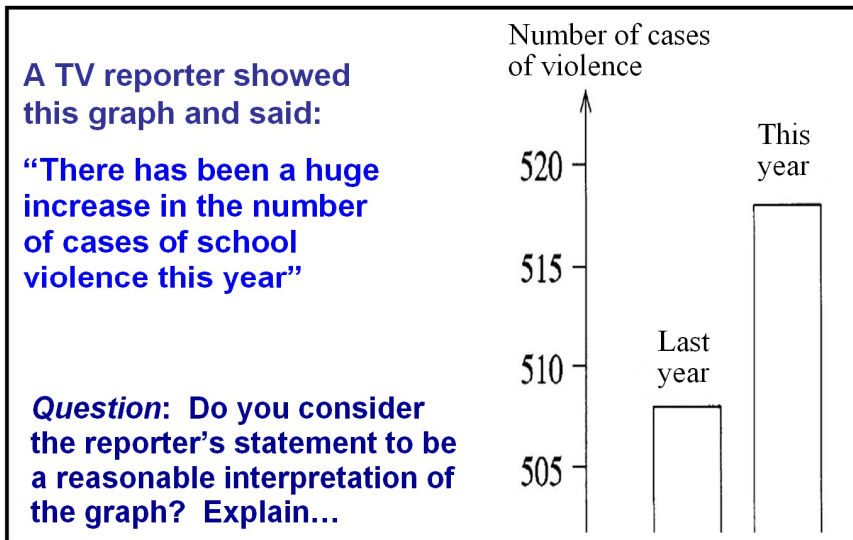
**Discuss in your group** - What are the differences between the three tasks, in terms of:

- (1) The **statistical ideas/content** (or other knowledge) invoked by each task,
- (2) The (relative) **educational value** for statistics education (or math education).

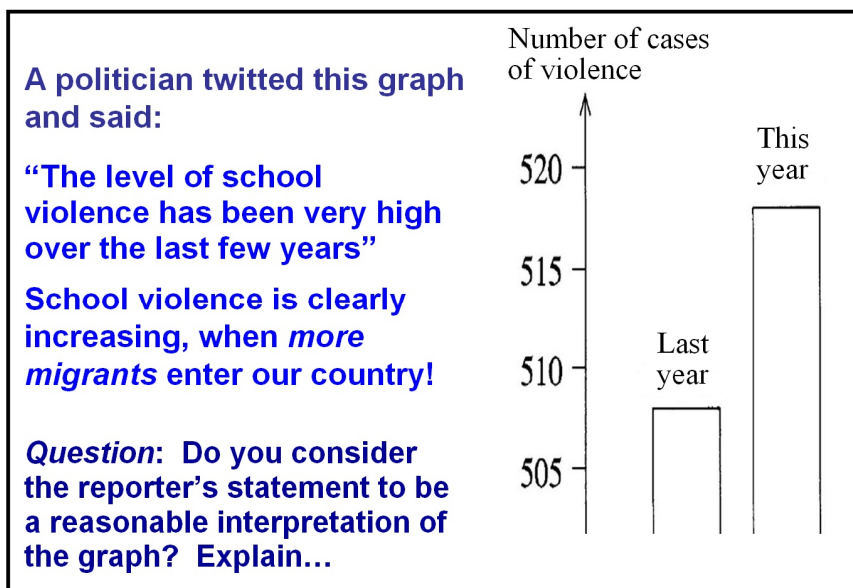
**Task A:** (Source: GAISE 2016 college report, p.105)

Suppose that 20% of undergraduate students at a university own an iPad and 60% of graduate students at the university own an iPad. Is it reasonable to conclude that 40% (the average of 20% and 60%) of all students at the university (undergraduate and graduate students combined) own an iPad? Explain why or why not, in plain language.

**Task B:** (Source: Iddo Gal, based on TIMSS 1998, PISA 2003, ALL 2006)



**Task C:** (Source: Iddo Gal, CIVEEST 2019 Plenary paper)



## Activity 2: USA demographics & projections

Think of the students/learners you currently teach. Assume you want to develop their understanding of statistical (and math-related) topics, and improve their thinking about how statistics relates to the adult world and to societal issues.

You searched information about basic demographics, and found population projections for 2020-2060, by the U.S. Census Bureau. Here are two extracts from a long report.

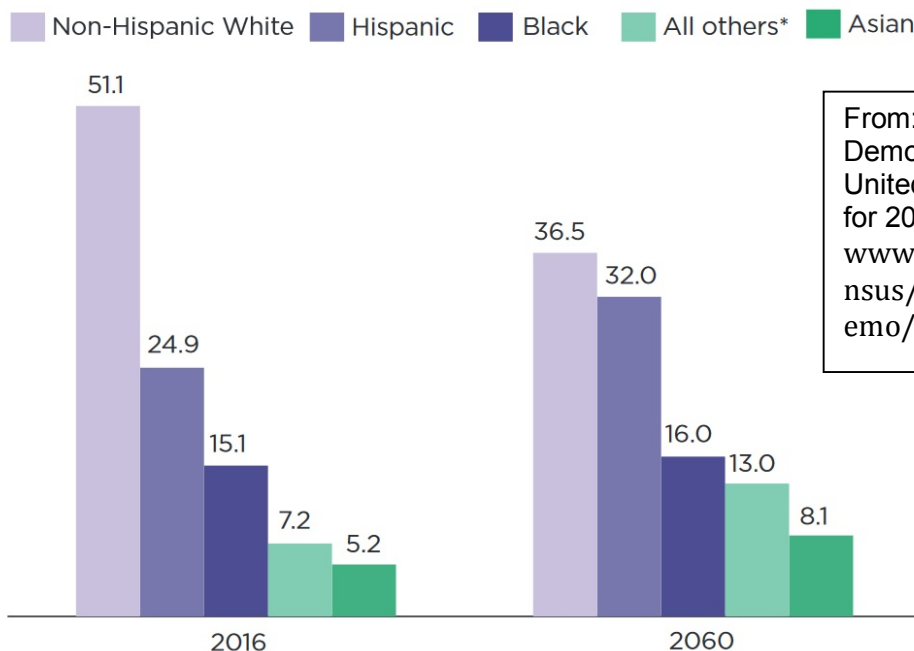
### Discuss in your group:

- (1) How is this **connected with the content in a typical Intro / Stat 101 class**?
- (2) Does this have **educational value** for stat education (or math education)? Why?
- (3) Think about **3-4 tasks/questions/assignments** (as homework, in class) that you could give your students, based on this stuff. You want to *engage* them with the material and the social issues + *develop their understanding of* (civic) statistics.

**Table 1: Population by Age Group: Projections 2020 to 2060 (in Millions)**

Characteristic	Population					
	2016	2020	2030	2040	2050	2060
<b>Total population . . . . .</b>	<b>323.1</b>	<b>332.6</b>	<b>354.8</b>	<b>373.1</b>	<b>388.3</b>	<b>403.7</b>
Under 18 years . . . . .	73.6	73.9	75.4	76.8	77.9	79.8
18 to 44 years . . . . .	116.0	119.2	125.0	126.3	129.3	132.3
45 to 64 years . . . . .	84.3	83.4	81.3	89.1	95.4	97.0
65 years and over . . . . .	49.2	56.1	73.1	80.8	85.7	94.7
85 years and over . . . . .	6.4	6.7	9.1	14.4	18.6	19.0
100 years and over . . . . .	0.1	0.1	0.1	0.2	0.4	0.6

**Figure 3: Racial and Ethnic composition of children under 18 (in percent)**



From: Vespa et al (2018).  
Demographic turning points for the  
United States: Population projections  
for 2020 - 2060. US Census Bureau.  
[www.census.gov/content/dam/Census/library/publications/2018/demo/P25\\_1144.pdf](http://www.census.gov/content/dam/Census/library/publications/2018/demo/P25_1144.pdf)

## Activity 3: Gender Pay Gap

Think of the students/learners you currently teach. Assume you want to develop their understanding of statistical (and math-related) topics, and improve their thinking about how statistics relates to the adult world and to societal issues.

You decided to take on topics debated in the public sphere, and saw that a lot of attention is given to “gender pay gap”, with statements and statistics presented by many politicians and activists. To learn more about this, you looked up the Wikipedia definition, and found the search result below (the text below is just an excerpt - there is much more in Wikipedia on this topic).

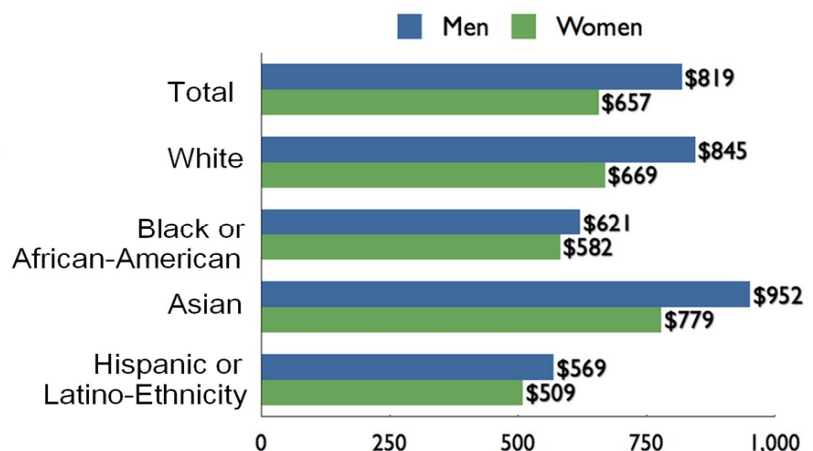
### Discuss in your group:

- (1) How is this **connected with the content in a typical Intro / Stat 101 class**?
- (2) Does this have **educational value** for stat education (or math education)? Why?
- (3) Think about **1-2 tasks/questions/assignments** (as homework, in class) that you could give your students, based on this stuff. You want to *engage* them with the material and the social issues + *develop their understanding of* (civic) statistics.



### Gender pay gap USA

The gender pay gap in the United States is the ratio of **female-to-male** median or average (depending on the source) yearly earnings among full-time, year-round workers.



### Gender pay gap in the United States - Wikipedia

[https://en.wikipedia.org/wiki/Gender\\_pay\\_gap\\_in\\_the\\_United\\_States](https://en.wikipedia.org/wiki/Gender_pay_gap_in_the_United_States)

The average woman's *unadjusted* annual salary has been cited as 78%<sup>[2]</sup> to 82%<sup>[3]</sup> of that of the average man's. However, after *adjusting* for choices made by male and female workers in college major, occupation, working hours and parental leave, multiple studies find that pay rates between men and women varied by 5–6.6% or, women earning 94 cents to every dollar earned by their male counterparts.

The extent to which discrimination plays a role in explaining gender wage disparities is somewhat difficult to quantify, due to a number of potentially *confounding variables*, ...

## Activity 4: Poverty, ‘Risk of Poverty’

Think of the students/learners you currently teach. Assume you want to develop their understanding of statistical (and mathematical) topics, and improve their thinking about how statistics relates to the adult world and to societal issues.

You decided to look into a more pervasive and broad topic – *poverty*. You looked both for information about Europe and USA, to get some sense at how this topic is being examined or addressed in different countries.

**For Europe**, you found on the Eurostat (The EU Statistical agency) webpage key highlights from its report for 2017 (the last year for which data are available).

**For USA**, search for “Poverty in the USA” in Wikipedia.

**Discuss in your group:**

- (1) Do these have **educational value** for stat education (or math education)? Why?
- (2) Think about **3-4 tasks/questions/assignments** (as homework, in class) that you could give your students, based on this stuff. You want to *engage* them with the material and the social issues + *develop their understanding* of (civic) statistics.

[https://ec.europa.eu/eurostat/statistics-explained/index.php/People\\_at\\_risk\\_of\\_poverty\\_or\\_social\\_exclusion](https://ec.europa.eu/eurostat/statistics-explained/index.php/People_at_risk_of_poverty_or_social_exclusion)

**eurostat**  
Statistics Explained

## People at risk of poverty or social exclusion

In 2017 (see Figure 1), there were 53.5 million people in the EU-28 living in households that faced **income poverty** (but neither **severe material deprivation**, nor **very low work intensity**). The statistical threshold for “income poverty” is defined as a household having to make do with only 60 percent of the median monthly income as measured across households. 13.8 million persons experienced severe **material deprivation** (e., cannot pay for heating; but neither of the other two risks) and 11.9 million people were living in households with **very low work intensity** (i.e., mostly out of the labor force; but facing neither of the other two risks).

An additional 26.5 million people lived in households facing two out of three of these risks, while a further 7.1 million people lived in households where all three of these risks were present.

Although people are considered to be at risk of poverty or social exclusion as soon as they face one of the above three risks, the figures above mean **almost one third (29.8 %) of the total number of people at risk of poverty or social exclusion within the 28 European countries faced all three risks in 2017.**

A reduction in the number of persons at risk of poverty or exclusion in the EU is one of the key policy targets of *Europe 2020 strategy*. Compared with 2016, the number of people at risk of poverty or exclusion in 2017 had decreased by 5.1 million, equivalent to a 1.1 percentage point (pp) decrease in the share of the total population, leading to the lowest share of the population which is at risk of poverty or social since data became available in 2010.

## 1. Six key recommendations by ProCivicStat partners

#1	<b>Statistics education activities should promote engagement with social issues and develop learners' critical understanding of statistics about key civic phenomena.</b>
#2	<b>Use relevant data and texts, and highlight the multivariate, dynamic and aggregated nature of social phenomena.</b>
#3	<b>Embrace technologies that enable rich visualizations and interactions with data about relevant social phenomena.</b>
#4	<b>Teaching methods should develop skills of critical interpretation of a wide variety of data and text sources.</b>
#5	<b>Assessments should examine the ability to investigate and critically understand data, statistics findings and messages about key social phenomena.</b>
#6	<b>Promoting the understanding of civic statistics requires a systemic change and collaboration by relevant stakeholders.</b>

Source: ProCivicStat *Call for Action*, at: <http://iase-web.org/ISLP/PCS>

## 2. Beyond Stat 101: Promote valuable tasks & meaningful statistics

	Type of task / question	More details
1	Clarification, literal reading	Understand text / display Reading the data / text
2	Simple computations New representations	find new values ratios /probabilities
3	Reason about or with the data / findings	Explore differences, predict trends or future values based on given info, apply a model
4	Use external sources	Analyze a dataset
5	Critique the statistical analysis / display / findings	Consider the quality of data sources / methods / analysis / flaws / biases
6	Critique the <b>interpretation</b>	Logic of conclusions, claims about causality, ...
7	Explore <b>causal factors and correlates</b>	What variables could affect the phenomena? Are there confounders? Does it behave differently in subgroups (disaggregation)?
8	Discuss <b>social impact and relevance for public policy</b>	What are the implications? Needed decisions or changes? New data needs?

Source: Gal, I. (in preparation). Portions were presented in my CIVEEST 2019 plenary talk and paper, URL: <https://www.ugr.es/~fqm126/civeest.html> (click on "plenary lectures")

### 3. Key features of civic statistics

1. **Multivariate phenomena.** Social and economic variables of interest do not stand in isolation. The description and understanding of civic phenomena involves looking at related groups of variables that are correlated (and may have cause-and-effect relationships), interact with each other, or have non-linear relationships.
2. **Aggregated data.** Statistics about society are often reported not with regard to continuous raw variables per se, but involve data that are grouped in diverse ways, e.g., combined into indicators, or reported for multiple subgroups, sometimes using qualitative variables. Further, data are often aggregated by combining conceptual and statistical *models* of the phenomena of interest. (For example: defining a "poverty line" as half (or some other portion) of the median disposable income, weighted by household size; or defining weight groups (e.g., normal, overweight, obese) based on values on the distribution of the BMI index).
3. **Dynamic data.** Civic statistics are often not the result of a one-time data collection effort (e.g., unlike a single survey discussed in an typical statistics course) but based on data collected periodically (e.g., each month, quarter, year) or on a comparative basis (e.g., in multiple countries). Consequently, data are often reported as a trend over time, and may be updated when new data become available or old data are re-evaluated, leading to the creation of a more complex information space compared to the simplified data used in teaching introductory statistics.
4. **Involve rich/diverse texts.** Statistical information about society is brought to the public mainly via *texts*, such as by press releases or reports published by statistics producers, or via articles in the media. Thus, text is a primary medium for communicating statistics. The public needs to be capable of comprehending and critically interpreting different genres of writing.
5. **Involve rich/diverse visualizations.** Since data and findings about social phenomena are multivariate, aggregated, and dynamic, their description across time or comparison units requires the use of diverse types of representations, and may combine static, dynamic, and interactive visualizations and tabular forms.
6. **The social context of civic statistics.** Civic statistics deal with topics of importance to society at large or to large subgroups in it. Interpreting civic statistics (e.g., about migration, poverty, employment, equality, etc.) requires attention to the broader world context. Understanding the meaning or societal importance of civic statistics, or the causes for their dynamic progression over time, requires familiarity with and sensitivity to a network of correlates, causal factors, and consequences for individuals, communities, stakeholders, and society at large.

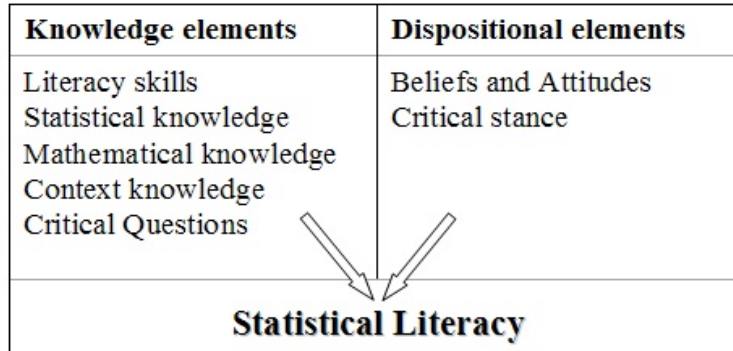
Source: ProCivicStat *Call for Action*, at: <http://iase-web.org/ISLP/PCS>

**Copyright:** All ProCivicStat materials and publications are copyrighted © but can be freely used for educational, non-profit, and academic purposes, provided that the ProCivicStat Partners and the ProCivicStat website are acknowledged and credited as the creator and source of the materials.

### 4. About statistical literacy

Statistical literacy has been defined in several ways in the literature.

My own definition (Gal, 2002) views statistical literacy as "The motivation and ability to access, understand, interpret, critically evaluate, and if relevant express opinions, regarding statistical messages, data-related arguments, or issues involving uncertainty and risk".

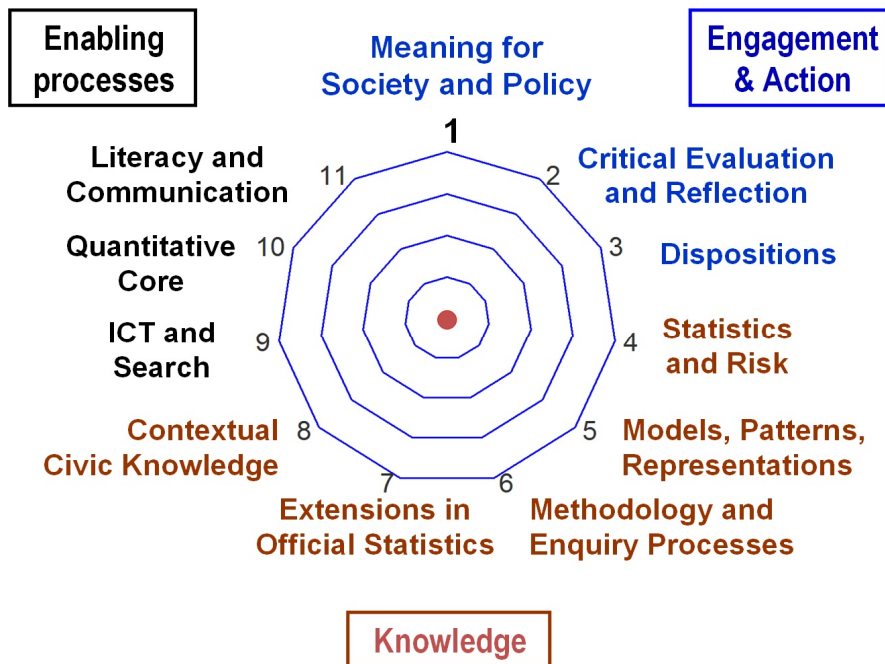


A model of statistical literacy as an actionable competence

Source: Gal, I. (2002). Adults' statistical literacy: Meanings, components, responsibilities. *International Statistical Review*, 70(1), 1-25.

### 5. PCS conceptual framework - 11 facets of civic statistics

The model below argues that the ability to engage with and understand civic statistics involves 11 related facets, organized in three groups or dimensions:



Sources: (1) [http://iase-web.org/islp/pcs/documents/Conceptual\\_framework\\_brief.pdf](http://iase-web.org/islp/pcs/documents/Conceptual_framework_brief.pdf)  
 (2) Gal, I., & Ograjenšek, I. (2017). Official statistics and statistics education: Bridging the gap. *Journal of Official Statistics*, 33(1), 79-100.