Promoting Civic Engagement via Exploration of Evidence:
Challenges for Statistics Education

Erasmus+

Workshop W07 at USCOTS 2019 ─ 16 May 2019, 13:00-16:30

Developing understanding of civic statistics: The important things we miss in Stat 101

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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), 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 with six key recommendations*** (see p.9), and many integrated resources including conceptual frameworks, datasets, lesson plans, workshops, and various guidelines.

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

Workshop plan:

Part	Details	Time	Start
1	Opening, background, needs	15	1:00
2	Activity 1: Warm-up, statistics and context	25	1:15
3	Activity 2: Population projections	30	1:40
4	Activity 3: Gender pay gap	30	2:10
	~~ Break ~~~	15	2:40
5	ProCivicStat conceptual frameworks	20	2:55
6	Activity 4: Poverty + Risk of Poverty	30	3:15
7	How to implement civic statistics, beyond Stat 101 More about PCS resources, CivicStatMap tool	20	3:45
8	General Discussion, closure	25	4:05

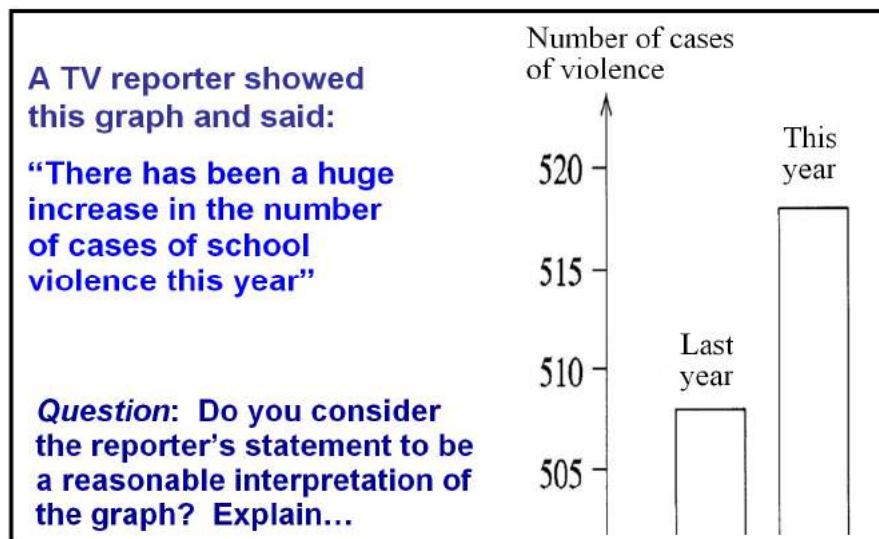**Activity 1:** Read tasks A/B/C, which may be given as class or home assignments.

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).
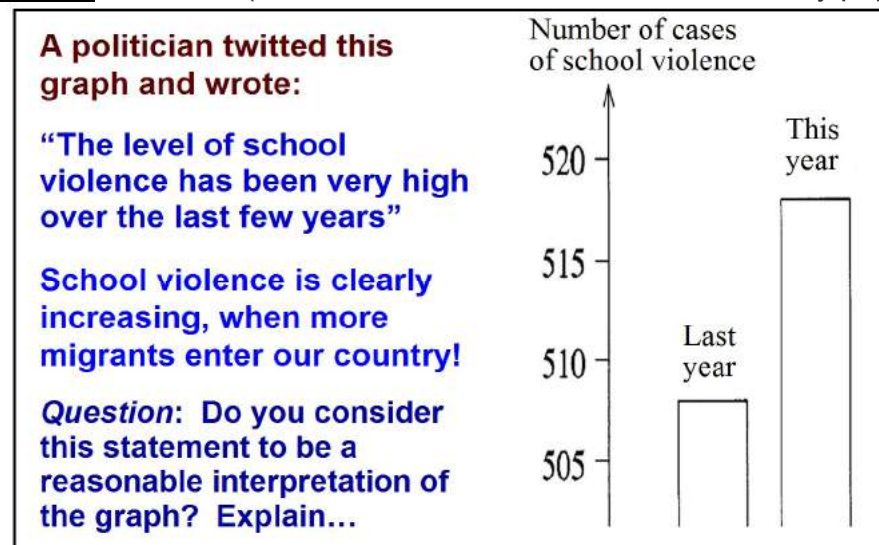

Task A: (Source: GAISE 2016 college report, p.105)

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 simple words.

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

A TV reporter showed this graph and said:

"There has been a huge increase in the number of cases of school violence this year"

Question: Do you consider the reporter's statement to be a reasonable interpretation of the graph? Explain…

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

A politician twitted this graph and wrote:

"The level of school violence has been very high over the last few years"

School violence is clearly increasing, when more migrants enter our country!

Question: Do you consider this statement to be a reasonable interpretation of the graph? Explain…

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.
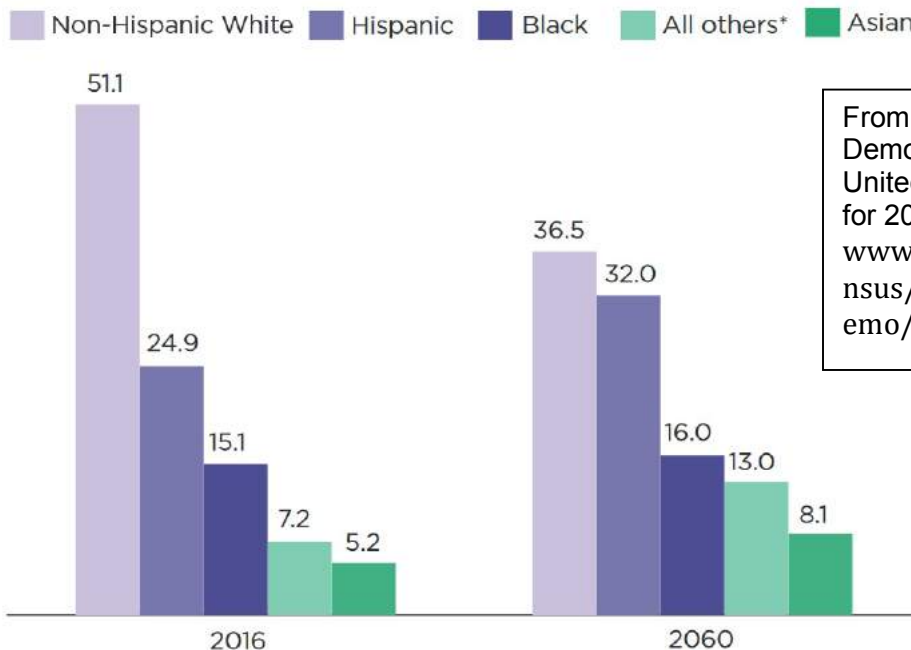
Discuss in your group:

(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
Total population	**323.1**	**332.6**	**354.8**	**373.1**	**388.3**	**403.7**
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)

Non-Hispanic White · Hispanic · Black · All others* · Asian

2016: 51.1, 24.9, 15.1, 7.2, 5.2
2060: 36.5, 32.0, 16.0, 13.0, 8.1

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
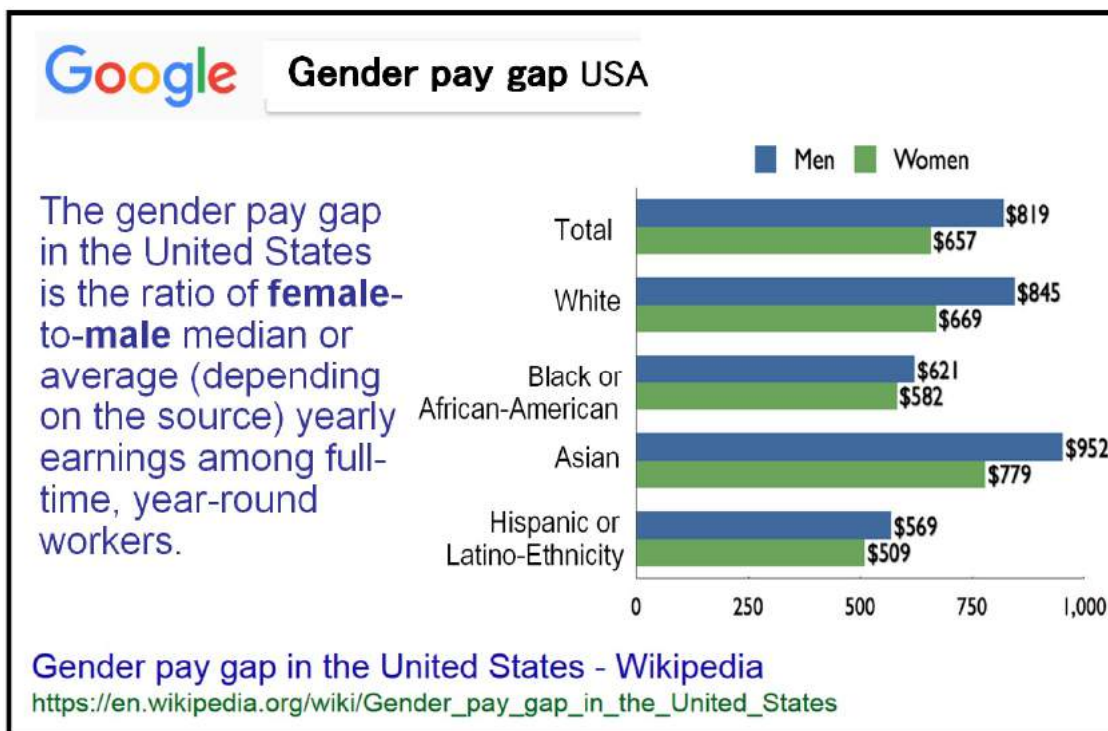
Activity 3: Gender Pay Gap

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.

The average woman's *unadjusted* annual salary has been cited as 78%[2] to 82%[3] 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.

Optional additional information: about Gender Gaps in Pay and Employment.

Note: This text combines excerpts from a Eurostat report + a graph from an OECD report.

International Women's Day - 8 March 2017

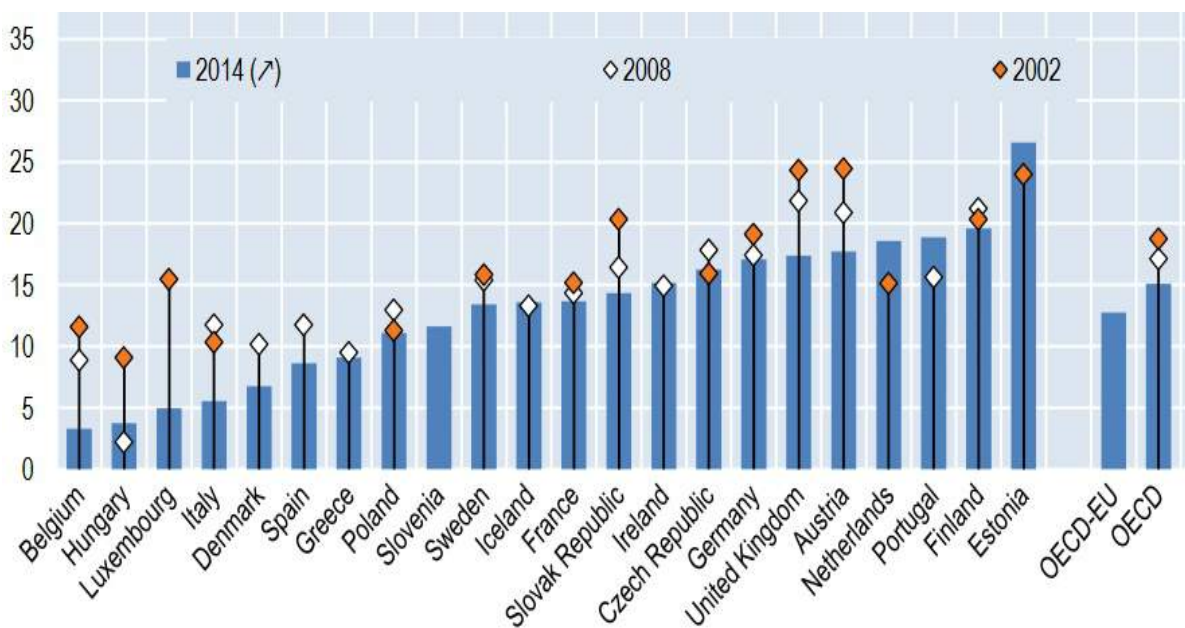### Only 1 manager out of 3 in the EU is a woman!

Earning on average almost a quarter less than a man

Nearly 7.3 million persons hold managerial positions in companies with 10 workers or more in the European Union (EU): 4.7 million men (65% of all managers) and 2.6 million women (35%). Thus, although representing about half of all employed persons in the EU, women continue to be under-represented amongst managers.

In addition, differences between women and men also concern wages. Those women in managerial positions in the EU earn 23.4% less on average than men, i.e., female managers earn on average 77 cents for every euro a male manager makes per hour. This pattern at EU level masks significant differences between member states regarding both positions and pay.

This information, extracted from the yearlong "Structure of Earnings survey" for reference year 2014, is published by Eurostat, the statistical office of the European Union, on the occasion of International Women's Day. This News Release only shows a small part of the large amount of gender-based data available at Eurostat.

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The graph below is adapted from a 2017 OECD report "The Socio-Economic Divide in Europe". It shows data about gender pay gap (percent difference in average salary of women compared to men) in some European countries, in 2002, 2008 and 2014:

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, you looked up "Poverty in the USA" in Wikipedia. Both texts appear below and on the next two pages.

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

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 social exclusion in the EU is one of the key policy targets of the *Europe 2020 strategy*. Compared with 2016, the number of people at risk of poverty or social 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.
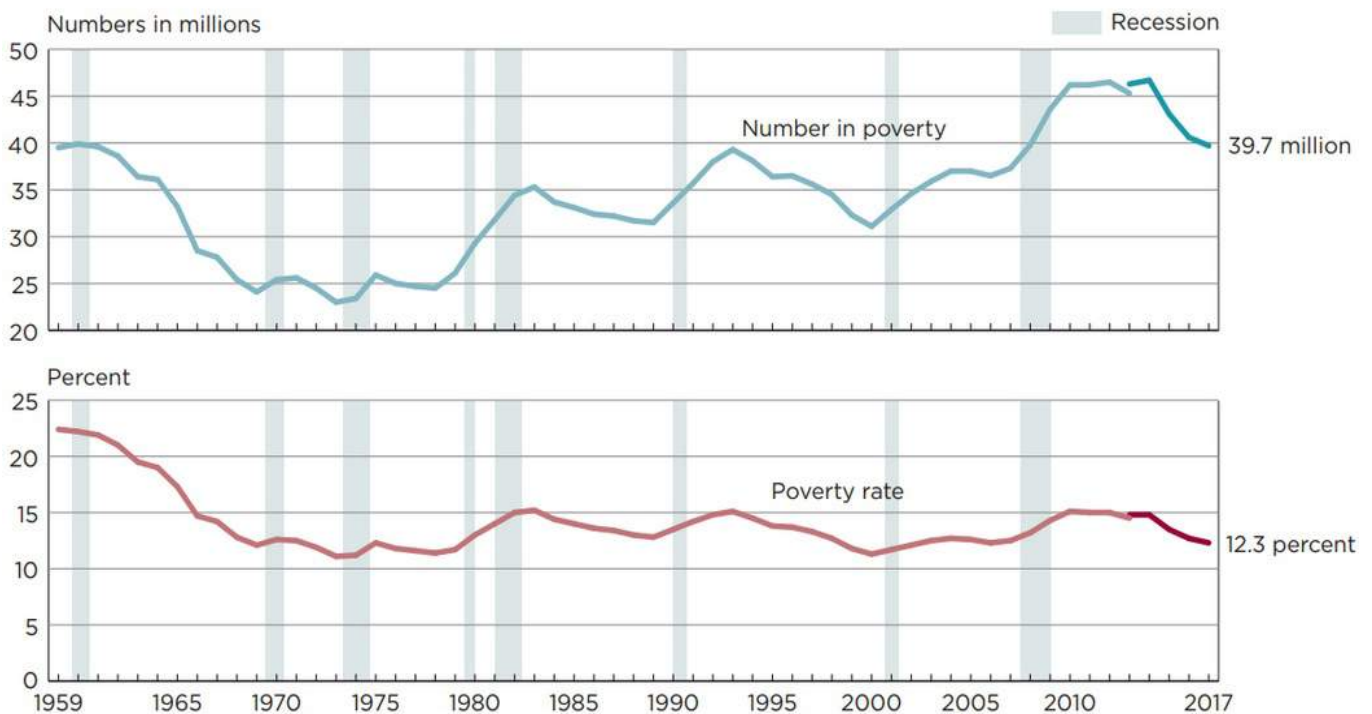
Poverty in the United States

[Poverty](#) is a state of [deprivation](#), lacking the usual or socially acceptable amount of money or material possessions.[1] The most common measure of poverty in the U.S. is the ["poverty threshold"](#) set by the U.S. government. This measure recognizes poverty as a lack of those goods and services commonly taken for granted by members of mainstream society.[2] The official threshold is adjusted for [inflation](#) using the [consumer price index](#).

Most people in the United States will spend at least one year below the poverty line at some point between ages 25 and 75.[3] Poverty rates are persistently higher in rural and inner city parts of the country as compared to suburban areas.[4][5]

Estimates of the number of people in the United States living in poverty are nuanced. One organization estimated that in 2015, 13.5% of Americans (43.1 million) lived in poverty.[6] Yet other scholars underscore the number of people in the USA living in "near-poverty," putting the number at around 100 million, or nearly a third of the U.S. population.[7] Starting in the 1930s, [relative poverty](#) rates have consistently exceeded those of other wealthy nations.[8] The lowest poverty rates are found in New Hampshire, Vermont, Minnesota and Nebraska, which have between 8.7% and 9.1% of their population living in poverty.[9]

Number in Poverty and Poverty Rate: 1959 to 2017

Note: The data for 2013 and beyond reflect the implementation of the redesigned income questions. The data points are placed at the midpoints of the respective years. For information on recessions, see Appendix A. For information on confidentiality protection, sampling error, nonsampling error, and definitions, see <www2.census.gov/programs-surveys/cps/techdocs/cpsmar18.pdf>.

Source: U.S. Census Bureau, Current Population Survey, 1960 to 2018 Annual Social and Economic Supplements.

In 2009, the number of people who were in poverty was approaching 1960s levels that led to the national War on Poverty.[10] In 2011 extreme poverty in the United States, meaning households living on less than $2 per day before government benefits, was double 1996 levels at 1.5 million households, including 2.8 million children.[11] In 2012, the percentage of seniors living in poverty was 14% while 18% of children were.[12] The addition of Social Security benefits contributed more to reduce poverty than any other factor.

Recent census data shows that half the population qualifies as poor or low income,[14] with one in five Millennials living in poverty.[15] Academic contributors to *The Routledge Handbook of Poverty in the United States* postulate that new and extreme forms of poverty have emerged in the U.S. as a result of neoliberal policies and globalization, which have rendered economically marginalized communities in need of control and punishment.[16]

In 2011, child poverty reached record high levels, with 16.7 million children living in food insecure households, about 35% more than 2007 levels.[17] A 2013 UNICEF report ranked the U.S. as having the second highest relative child poverty rates in the developed world.[18] According to a 2016 study by the Urban Institute, teenagers in low income communities are often forced to join gangs, save school lunches, sell drugs or exchange sexual.[19]

There were about 643,000 sheltered and unsheltered homeless people nationwide in Jan 2009. Almost two-thirds stayed in an emergency shelter or transitional housing program and the other third were living on the street, in an abandoned building, or another place not meant for human habitation. About 1.56 million people, or about 0.5% of the U.S. population, used an emergency shelter or a transitional housing program between October 1, 2008 and September 30, 2009.[20] Around 44% of homeless people are employed.[21]

In June 2016, the IMF warned the USA that its high poverty rate needs to be tackled urgently by raising the minimum wage and offering paid maternity leave to women to encourage them to enter the labor force.[24] In Dec 2017, the UN special rapporteur on extreme poverty and human rights, Philip Alston, …. declared the state of Alabama to have the "worst poverty in the developed world".[25] Alston's report in May 2018 highlights that 40 million people live in poverty and over five million live "in 'Third World' conditions.

Extra activity - How's Life in the USA?

Civic statistics can portray many "good news" and positive trends about our society.

To illustrate, below is a URL and some excerpts regarding the "Better life index", which can engage students with other kinds of civic and economic statistics.

Discuss in your group: Educational value.... tasks / questions / assignments...

How's Life in the USA? The Better Life Index Report

Source: http://www.oecdbetterlifeindex.org/countries/united-states

The United States performs very well in many measures of well-being relative to most other countries in the Better Life Index. The USA ranks at the top in housing, and income and wealth. They rank above the average in health status, jobs and earnings, education and skills, personal security, subjective well-being, environmental quality, and civic engagement. They rank below average in work-life balance and social connections. These rankings are based on available selected data.

Money, while it cannot buy happiness, is an important means to achieving higher living standards. In the United States, **the average household net-adjusted disposable income per capita is USD $44,049 a year**, much higher than the OECD average of USD 30 563 a year, and the highest figure in the OECD. But there is a considerable gap between the richest and poorest – the top 20% of the population earn about eight times as much as the bottom 20%.

1. Six key recommendations by ProCivicStat partners

Source: **ProCivicStat** *Call for Action*, at: http://iase-web.org/islp/pcs

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

2. 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.

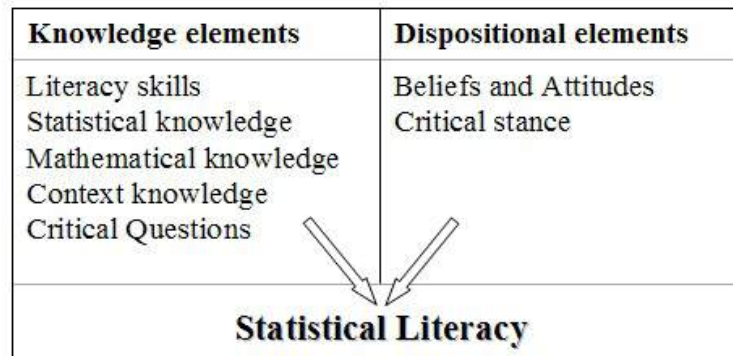Source: **ProCivicStat** *Call for Action*, at: http://iase-web.org/islp/pcs

3. About statistical literacy

Statistical literacy has been defined in several ways in the literature.
My own definition (Gal, 2002) reads:

> 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.

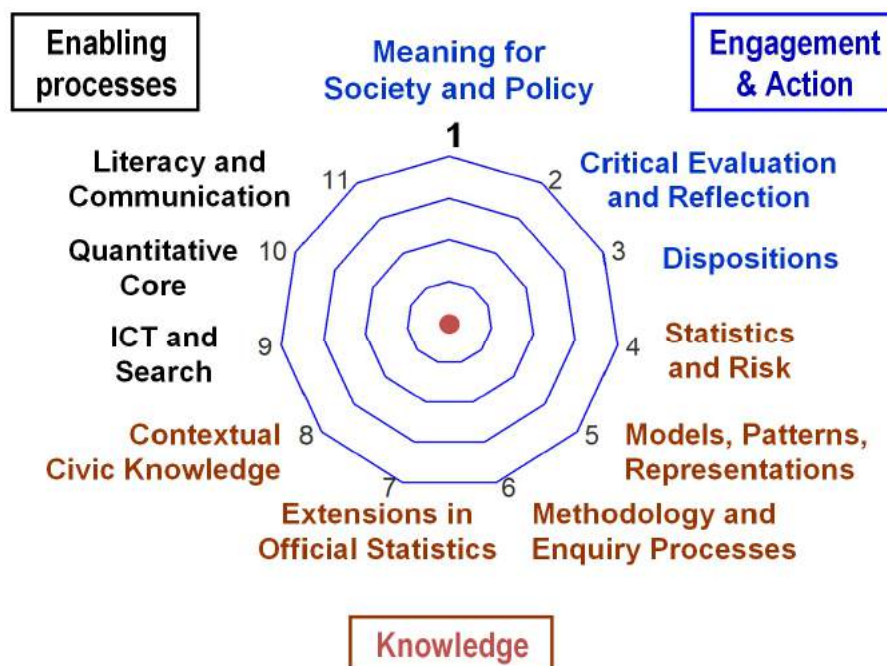| Knowledge elements	Dispositional elements
Literacy skills	Beliefs and Attitudes
Statistical knowledge	Critical stance
Mathematical knowledge	
Context knowledge	
Critical Questions	
Statistical Literacy	

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.*

4. 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:

Source: http://iase-web.org/islp/pcs/documents/Conceptual_framework_brief.pdf

5. 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 **interpretation**	Logic of conclusions, claims about causality, ...
7	Explore **causal factors and correlates**	What variables could affect the phenomena? Are there confounders? Does it behave differently in sub-groups (*disaggregation*)?
8	Discuss **social impact and relevance for public policy**	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")

6. A visual overview of ProCivicStat outputs and plans

Public discourse	Call for Action & Recommendations		PCS Book

Broad Frameworks	Conceptual Framework of needed skills	Guidelines for task design & assessment	Course designs - for all students - for pre-service

Instructional Resources	CivicStatMap	Lesson plans	Dataset guides	Workshop and visualization guides
	For Teachers		*For Students*	

Supporting materials	Conference proceedings	Papers by PCS partners	PCS website	Bibliography, links, etc