ProCivicStat © - Workshop for the IASE Satellite, Rabat 11-13 July 2017

Reconceptualising Statistical Literacy

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This workshop explores the dimensions of statistical literacy in the context of contemporary society, and is based on the work of ProCivicStat. We aim to provoke reflections and discussions about the nature of 'statistical literacy' and the implications for statistics education.

ProCivicStat is designed to engage high school and undergraduate students with evidence and statistical analysis relevant to the progress of society, via topics such as such as poverty, migration and inequality. We call this Civic Statistics.

List of tasks in this booklet

Task #	Content focus	Topic	Geography	Source
Task 1	Examinations	Means and medians	Anywhere	GAISE
Task 2	Employment	Female employment	Norway	Eurostat
Task 3	World population growth	Population in China and the USA	China, USA	Gapminder Foundation
Task 4	Environment	Arctic ice volume	World	Washington University USA
Task 5	Life expectancy	Years to live	USA	Social Security Administration
Task 6	Human development	Infant development	Anywhere	CDC, USA
Task 7	Migration	European immigration	Europe	Eurostat
Task 8	Invasive monitoring	Tagging penguins	Antarctica	GAISE

ProCivicStat is a partnership of the Universities of Durham, Haifa, Ludwigsburg, Paderborn, Porto and Szeged, funded by the ERASMUS+ program of the European Commission: see **www.procivicstat.org**. The materials for this workshop are a refinement of the collaborative efforts which can be seen under *publications* on the PCS website.

Introduction

What is statistical literacy? UNESCO (2004) define literacy as: "... the ability to identify, understand, interpret, create, communicate and compute... Literacy involves a continuum of learning in enabling individuals to achieve their goals, to develop their knowledge and potential, and to participate fully in their community and wider society."

Here, we set out to provoke a discussion about the nature of statistical literacy in 2017 and beyond, as a starting point for a critique of current curriculum practices, and to stimulate ideas on how to move forward. We map out some dimensions of statistical literacy, and offer a tool for analysing tasks (and curricula).

One of our ambitions for the workshop is to improve our draft conceptualisation

Background - about ProCivicStat

Understanding social phenomena such as migration, climate change, and population growth requires familiarity with concepts and ideas not commonly found in introductory statistics courses. For example: relevant data are multivariate; relations are often non-linear; variables interact; data are often aggregated. Students also need more knowledge about the whole cycle of gathering evidence to inform policy, such as: methodology and enquiry processes; contextual knowledge; more exposure to official statistics; decision making and risk. There is also a need to develop student dispositions – a willingness to engage with complex problems, along with the ability to adopt a critical stance towards evidence and argument. The ProCivicStat project is predicated on the idea that, to equip young adults to face the challenges of an increasingly data-rich world and engage with statistics about society, current curricula would benefit from incorporating some new concepts. In the longer term, statistics education needs a 'from the ground up' rethink.

To support such developments, we are creating a conceptual structure to map out the knowledge, skills and dispositions associated with statistics that can be used to illuminate social phenomena, i.e., "civic statistics". Radar plots, using the facets set out in our conceptual framework (still a working draft, being developed in ProCivicStat by the Universities of Haifa and Durham), are a useful tool for analysing current assessment and learning resources, and to help develop materials that can help to prepare students for informed civic engagement in a data-rich world. The facets and radar plots are explained in a separate document.

What to do:
 1. **Work on the tasks**
 2. **Answer the questions set for each task**
 3. **Fill in the Task Reflection Form, after each task**
 4. **Discuss your thoughts in your group, and adjust your notes appropriately**

- **Note 1 - the tasks**: Tasks were sampled from an infinite collection – we think there is enough variety to provoke your thinking!

- **Note 2 - the Task Reflection Form:** It asks you to think what knowledge & skills *you* used to understand the materials in the tasks, and to reflect critically about the conceptual framework. Thinking and reflection are a critical aspect of this workshop.

- **Note 3 - the Radar Plot:** A sketch of each dimension is provided in the accompanying notes.

Please send us feedback!: **Jim Ridgway** jim.ridgway@durham.ac.uk; **James Nicholson** j.r.nicholson@durham.ac.uk; **Iddo Gal** <iddo@research.haifa.ac.il>

Task 1: GAISE Item 4

Background: The Guidelines for Assessment and Instruction in Statistics Education (GAISE) project has created two reports with recommendations for introductory statistics courses (college level) and statistics education in Pre-K-12 years. These reports have been endorsed by the American Statistical Association. The reports contain very useful appendices: one of these provides examples of assessment items.
See http://www.amstat.org/asa/files/pdfs/GAISE/GaiseCollege_Full.pdf

Instructions:

1, Answer the question below. Then continue with the Instructions afterwards.

Q1: Does everyone who scores below the median on this exam necessarily have a negative z-score for this exam?

Explain.

Instructions (cont.):

2. Fill in the Task Reflection form.

3. Discuss your thoughts with your group (if needed, add more notes to the Form).

Task 2: Eurostat Charts: Female Employment

Background: The Eurostat widget is an application designed to be embedded in any website. It shows a selection of Eurostat data in a variety of ways. A number of different displays can be viewed. Here, we present a single sample chart.

Source: http://ec.europa.eu/eurostat/en/web/main/wtg

Instructions:

1. Examine the display above.

2. Answer the questions below:

    Q1: How is the 'Employment rate' measured?
    Q2: How would you change this graph?
    Q3: Explain your answer.
    Q4: What can you conclude from this graph?

3. Fill in the Task Reflection form.

4. Discuss your thoughts with your group (if needed, add more notes to the Form).

Task 3: Gapminder World

Background: *Gapminder* offers web-based interactive tools designed to develop public understanding of important facts about the state of the world.
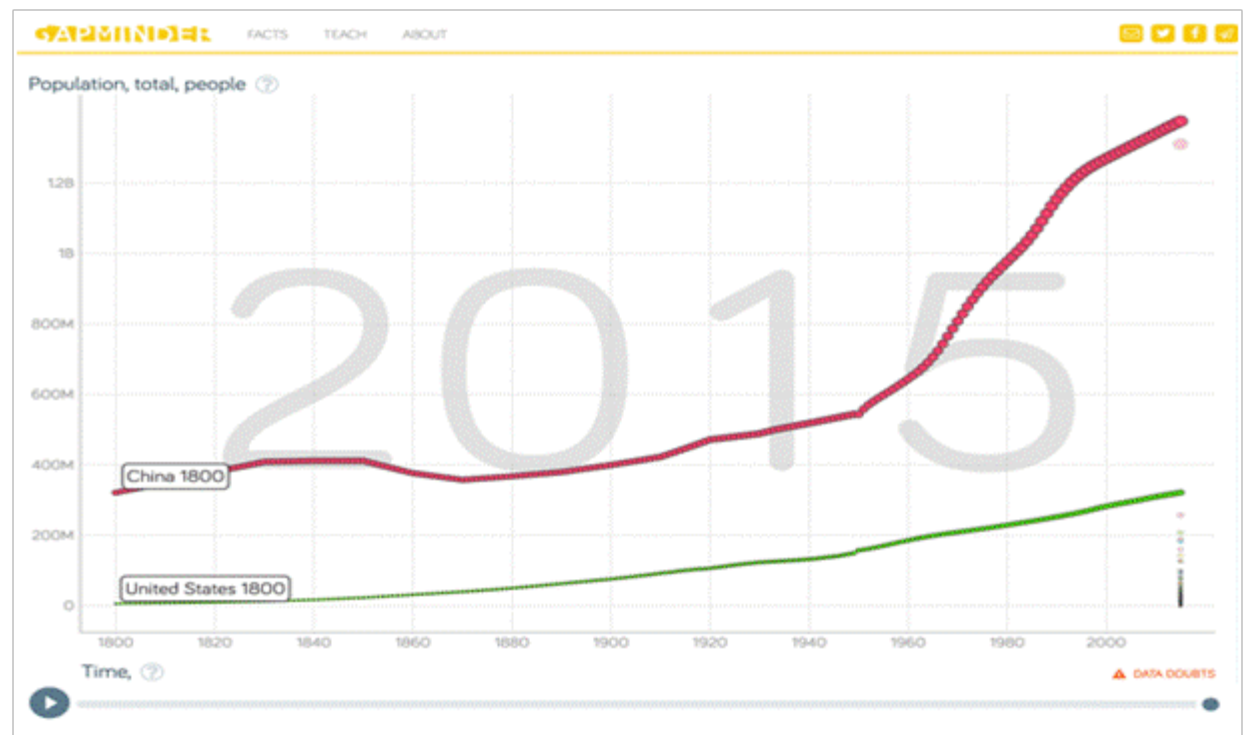See http://www.gapminder.org/world

The graph below is a snapshot that shows the population of China and the USA from 1800 to 2015.

Instructions:

1, Answer the question below. Then continue with the Instructions afterwards.

Q1: Should the USA insist that China reinstates its 'one-child' policy? Justify your answer.

Instructions (cont.):

2. Fill in the Task Reflection form.
3. Discuss your thoughts with your group (if needed, add more notes to the Form).

Task 4: Arctic Sea Ice Volume

Background: This graphic comes from the Polar Science Center at the University of Washington. There are no true measurements of total ice volume. The data shown are based on a model that is validated via submarine and satellite data; the observations are collected at the Unified Sea Ice Thickness Climate Data Record.

Instructions:

1. Search for "Arctic sea climate lab", or use this URL:
    http://www.climate-lab-book.ac.uk/files/2016/06/icevol.gif

    Under "climate spirals", run the visualization (i.e., click on photo as below) and start to explore it. Then continue with the Instructions below.
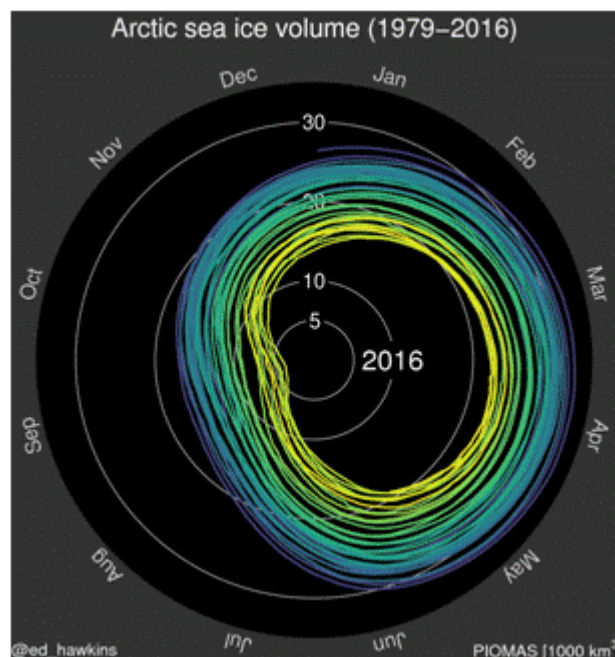
Instructions (cont.):

2. Answer the questions below:

    Q1: What variables are being visualised?
    Q2: What trends can you see within each year?
    Q3: What trends can you see across years?
    Q4: Is our planet getting warmer?

3. Fill in the Task Reflection form.

4. Discuss your thoughts with your group (if needed, add more notes to the Form).

Task 5: When Will You Die?

Background: This graphic comes from Nathan Yau's Flowingdata website. The original data is taken from the Actuarial Life Table of the Social Security Administration (USA).
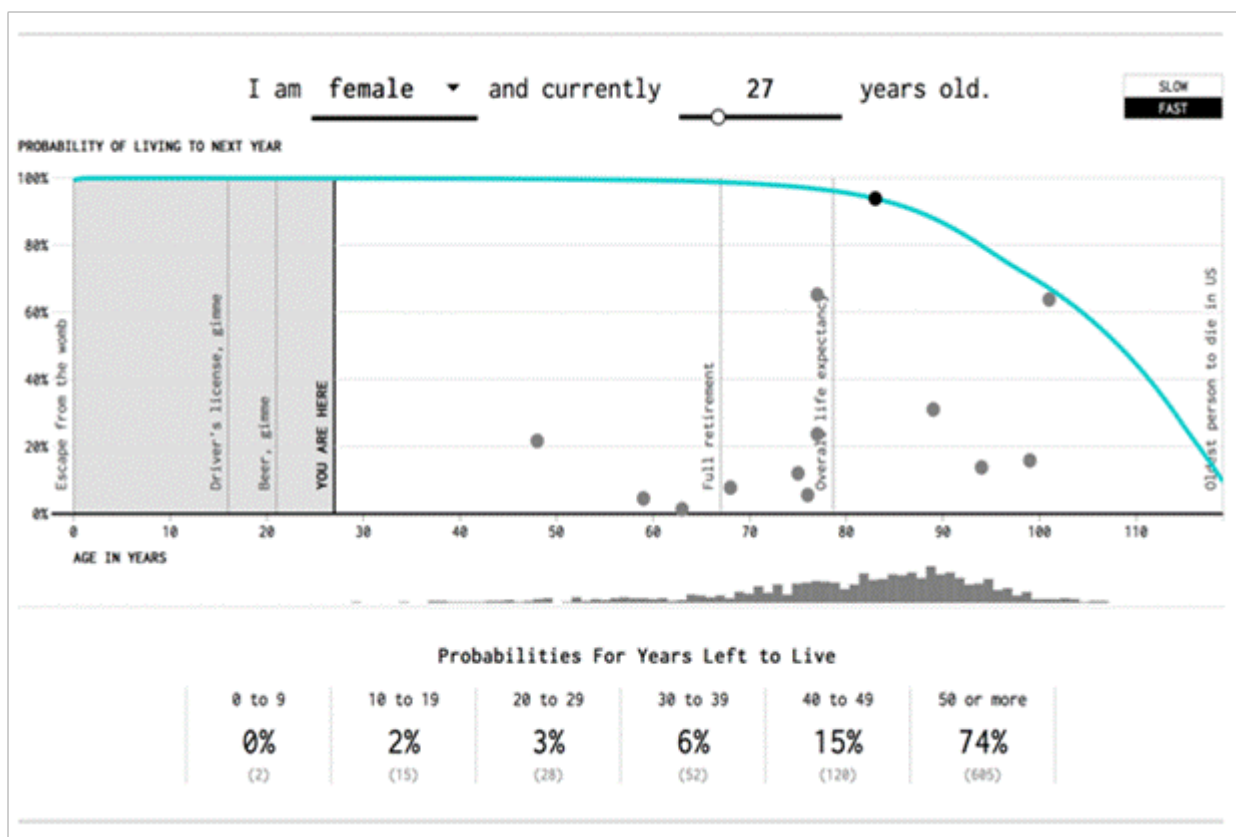
Source: https://www.ssa.gov/oact/STATS/table4c6.html

Instructions:

1. Find the Flowingdata visualization on the web:
http://flowingdata.com/2015/09/23/years-you-have-left-to-live-probably

2. Run it (scroll down, read some text). Then continue with the Instructions below.

Instructions (cont.):

3. Answer the questions below:

   Q1: What does '74%' mean?
   Q2: When will *you* die?
   Q3: At what age should people be allowed retire?

4. Fill in the Task Reflection form.

5. Discuss your thoughts with your group (if needed, add more notes to the Form).

Task 6: Infant Development

Background: Growth curves are used in many countries to track the development of infants in order to identify abnormal patterns of development. These growth curves have been taken from the Centers for Disease Control and Prevention in the USA - see https://www.cdc.gov/growthcharts/clinical_charts.htm

Instructions:

1, Complete the tasks, then answer the question below. Then continue with the Instructions afterwards.

T1: Draw the trajectory of a girl who is normal at birth, then fails to thrive.
T2: Draw the trajectory of a girl who shows signs of becoming obese.
Q1: When might you NOT use these charts to plot developmental progress?

Instructions (cont.):
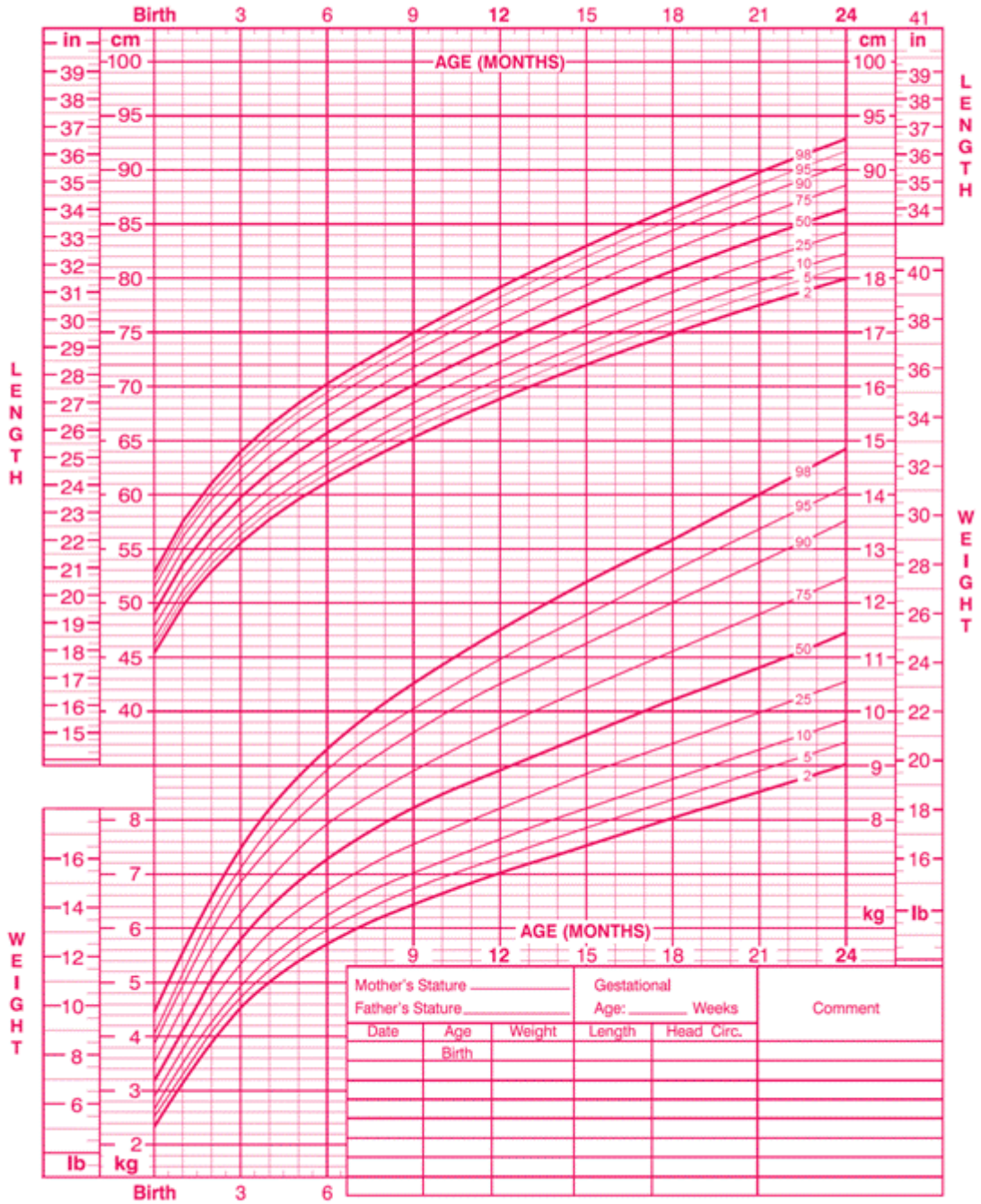
2. Fill in the Task Reflection form.

3. Discuss your thoughts with your group (if needed, add more notes to the Form).

Birth to 24 months: Girls
Length-for-age and Weight-for-age percentiles

NAME _____

RECORD # _____

Published by the Centers for Disease Control and Prevention, November 1, 2009
SOURCE: WHO Child Growth Standards (http://www.who.int/childgrowth/en)

Task 7: Eurostat Migration Statistics

Background; This task contains selected text and data from Eurostat, about the European Union. The website aims to not just present core data, but also annotate and explain the data to citizens. *Note*: The current task uses only a portion from the full text on the website, which also has many tables and graphs.

Source: http://ec.europa.eu/eurostat/statistics-explained/index.php/Migration_and_migrant_population_statistics

Instructions:

1. Read the text under "Read this" below

2. Analysis questions:

   Q1: If such an Immigration pattern continued, can it contribute to Europe's ability to cope with an aging workforce and growing elderly population?

   Q2: Which 3-4 countries were most affected by Immigration in 2014?

3. Fill in the Task Reflection form.

4. Discuss your thoughts with your group (if needed, add notes on Reflection form).

- - - - - **Read this** -

Migration flows

eurostat
Statistics Explained

1. A total of 3.8 million people *immigrated* to one of the EU-28 Member States during 2014, while at least 2.8 million *emigrants* were reported to have left an EU Member State. These total figures do not represent the migration flows to/from the EU as a whole, since they also include flows between different EU Member States.

2. Among these 3.8 million immigrants during 2014, as shown in Figure 1, there were an estimated 1.6 million citizens of non-member countries, 1.3 million people with citizenship of a different EU Member State from the one to which they immigrated, around 870 thousand people who migrated to an EU Member State of which they had the citizenship (for example, returning nationals or nationals born abroad), and some 12.4 thousand stateless people.

3. Immigrants into EU Member States in 2014 were, on average, much younger than the total population already resident in their country of destination. On 1 January 2015, the median age of the total population of the EU-28 was 42 years. By contrast, the median age of immigrants to EU-28 in 2014 was 28 years.

4. As shown in Figure 1 (next page), Germany reported the largest total number of immigrants (884.9 thousand) in 2014, followed by the United Kingdom (632.0 thousand), France (339.9 thousand), Spain (305.5 thousand) and Italy (277.6 thousand). Spain reported the highest number of emigrants in 2014 (400.4 thousand), followed by Germany (324.2 thousand), the United Kingdom (319.1 thousand), France (294.1 thousand) and Poland (268.3 thousand).

5. Relative to the size of the resident population, Luxembourg recorded the highest rates of immigration in 2014 (40 immigrants per 1 000 persons), followed by Malta (21 immigrants per 1 000 persons) and Ireland (15 immigrants per 1 000 persons) — see Figure 1. The highest rates of emigration in 2014 were reported for Cyprus (28 emigrants per 1 000 persons), Luxembourg (20 emigrants per 1 000 persons) and Ireland (18 immigrants per 1 000 persons).

Migrant population

6. There were 34.3 million people born outside of the EU-28 living in an EU Member State on 1 January 2015, while there were 18.5 million persons who had been born in a different EU Member State from the one where they were resident. Only in Hungary, Ireland, Luxembourg, Slovakia and Cyprus was the number of persons born in other EU Member States higher than the number born outside of the EU-28.

Figure 1: Immigration in Europe, by citizenship, 2014

	Total immigrants	Nationals		Non-nationals							
				Total		Citizens of other EU Member States		Citizens of non-member countries		Stateless	
	(thousands)	(thousands)	(%)	(thousands)	(%)	(thousands)	(%)	(thousands)	(%)	(thousands)	(%)
Belgium	124.8	17.6	14.1	105.9	84.9	64.6	51.8	41.3	33.1	0.0	0.0
Bulgaria	26.6	9.5	35.7	17.0	64.0	1.4	5.4	15.3	57.4	0.3	1.2
Czech Republic	29.9	5.8	19.3	24.1	80.7	14.8	49.3	9.4	31.4	0.0	0.0
Denmark	68.4	19.3	28.3	49.0	71.7	23.8	34.9	24.5	35.8	0.7	1.0
Germany	884.9	88.4	10.0	790.2	89.3	415.9	47.0	372.4	42.1	1.9	0.2
Estonia	3.9	2.6	65.5	1.3	34.4	0.2	4.0	1.2	29.6	0.0	0.8
Ireland	67.4	12.4	18.4	55.0	81.6	26.2	38.8	28.7	42.6	0.1	0.1
Greece	59.0	29.5	50.0	29.5	50.0	16.0	27.1	13.5	22.9	0.0	0.0
Spain	305.5	41.0	13.4	264.5	86.6	100.0	32.7	164.4	53.8	0.1	0.0
France	339.9	126.2	37.1	213.7	62.9	83.5	24.6	130.2	38.3	0.0	0.0
Croatia	10.6	4.8	45.3	5.8	54.6	2.3	21.9	3.5	32.6	0.0	0.1
Italy	277.6	29.3	10.5	248.4	89.5	68.1	24.5	180.3	64.9	0.0	0.0
Cyprus	9.2	1.4	15.3	7.8	84.7	3.7	40.8	4.0	43.9	0.0	0.0
Latvia	10.4	5.9	56.6	4.4	42.9	0.9	8.9	3.5	33.9	0.0	0.1
Lithuania	24.3	19.5	80.4	4.8	19.6	0.7	2.7	4.1	16.8	0.0	0.1
Luxembourg	22.3	1.3	5.9	21.0	94.0	16.5	74.1	4.4	19.9	0.0	0.0
Hungary	54.6	28.6	52.4	26.0	47.6	10.5	19.3	15.5	28.3	0.0	0.0
Malta	8.9	1.8	20.5	7.1	79.5	4.4	49.6	2.7	29.9	0.0	0.0
Netherlands	145.3	37.4	25.8	107.8	74.2	58.4	40.2	47.8	32.9	1.6	1.1
Austria	116.3	9.2	7.9	106.9	92.0	67.0	57.6	39.4	33.9	0.5	0.4
Poland	222.3	127.8	57.5	94.3	42.4	27.2	12.3	67.0	30.1	0.1	0.0
Portugal	19.5	10.2	52.4	9.3	47.6	3.4	17.3	5.9	30.3	0.0	0.0
Romania	136.0	123.9	91.1	12.1	8.9	1.2	0.9	10.9	8.0	0.0	0.0
Slovenia	13.8	2.5	18.3	11.3	81.7	3.3	23.6	8.0	58.1	0.0	0.0
Slovakia	5.4	2.9	54.9	2.4	45.1	2.0	36.8	0.4	8.3	0.0	0.0
Finland	31.5	7.9	24.9	23.1	73.4	9.5	30.1	13.6	43.1	0.1	0.2
Sweden	127.0	20.9	16.4	105.6	83.2	28.1	22.1	70.7	55.7	6.8	5.3
United Kingdom	632.0	81.3	12.9	550.7	87.1	263.6	41.7	287.1	45.4	0.0	0.0
Iceland	5.4	1.9	35.8	3.4	64.2	2.9	53.2	0.6	10.3	0.0	0.8
Liechtenstein	0.6	0.2	26.7	0.5	73.3	0.2	39.8	0.2	33.5	0.0	0.0
Norway	66.9	6.9	10.3	60.0	89.6	35.1	52.5	24.3	36.3	0.6	0.8
Switzerland	156.3	26.2	16.7	130.1	83.2	94.4	60.4	35.7	22.9	0.0	0.0

(*) The values for the different categories of citizenship may not sum to the total due to rounding and the exclusion of the category 'unknown citizenship' from the table.

Task 8: GAISE Item 1

Background: The Guidelines for Assessment and Instruction in Statistics Education (GAISE) project has created two reports with recommendations for introductory statistics courses (college level) and statistics education in Pre-K-12 years. These reports have been endorsed by the American Statistical Association. The reports contain very useful appendices: one of these provides examples of assessment items.
See http://www.amstat.org/asa/files/pdfs/GAISE/GaiseCollege_Full.pdf

Instructions:

1, Answer the questions below. Then continue with the Instructions afterwards.

Scientists use metal bands to tag penguins. Do the bands harm the birds?

Researchers investigated this question with a sample of 100 penguins near Antarctica. All of these penguins had already been tagged with RFID chips, and the researchers randomly assigned 50 of them to receive a metal band on their flippers in addition to the RFID chip. The other 50 penguins did not receive a metal band.

Researchers then kept track of which penguins survived for the 4.5-year study and which did not. They found that 16 of the 50 penguins with a metal band survived, compared to 31 of the 50 penguins without a metal band.

1. Calculate the difference in the proportions who survived between the two groups.

2. The *p*-value for comparing the two group's survival proportions turns out to be 0.005. Explain (as if to someone who has not studied statistics) what this p-value means: This is the probability of...

 3. Summarize your conclusion from this *p*-value. Do bands hurt the penguins? Be sure to address the issue of causation as well as the issue of significance. Also justify your conclusion.

Instructions (cont.):

2. Fill in the Task Reflection form.
3. Discuss your thoughts with your group (if needed, add more notes to the Form).