



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

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### Examining poverty and income inequalities with the help of Gapminder

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What?	Teaching Material for learning about poverty and income inequalities with the help of Gapminder
Why?	The examination of poverty and income inequality is important, due to their impacts on our lives.
Statistics topics	The module improves the understanding of correlation, linear and nonlinear relations, regressions, the visualization skills and the use of Gapminder
Level	Intermediate
Prerequisites	The required preliminary knowledge is to know different chart types (e.g. line, bar, scatter), to know different functions (especially linear and log functions) and to have some knowledge about correlation and regression models
Digital tools	Gapminder
Resources needed	PCs or notebooks with access to the internet
Lesson time	1 - 2 hours
Further remark	Suitable for group work or homework assignment

### What is Civic Statistics?

To be fully engaged, citizens need to be aware of and understand statistics regarding past trends, present situations, and possible future changes in diverse areas of importance to society such as demographics, employment, wages, migration, health, crime, poverty, access to services, energy, education, environment, human rights, and other domains. Statistics and data about these and related topics are collectively called here civic statistics. Information about civic statistics is provided by official statistics agencies and other public and private/non-profit statistics providers, and some of it is mediated to the public via print and visual media. Understanding of civic statistics is required for participation in democratic societies, but involves data that often are open, large-scale, official, multivariate in nature, and/or presented dynamically. Such statistics are usually not at the core of regular statistics instruction. These materials fill an important gap, not addressed in general education at school or university level.



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ProCivicStat is a cooperative project of six partners in five countries, funded through the Erasmus+ program of the European Union. ProCivicStat developed new methods for statistics instruction for high schools and universities that will contribute to young people's ability to understand quantitative evidence about key social phenomena that permeate civic life. ProCivicStat offers a platform for continuing cooperation, exchange of ideas, exploration and dissemination of theoretical concepts and concrete teaching materials for promoting civic engagement via exploration of evidence and understanding of statistics about society.

Visit the ProCivicStat website: <http://www.procivicstat.org> for more information.

### Introduction

This document is intended for university teachers who teach a first or second course in statistics.

The document contains a class plan with answers to questions. After reading this plan, you will have a deeper understanding on:

- ✓ The importance of poverty and income inequalities;
- ✓ The topics that can be covered when using this lesson plan;
- ✓ Software programs that can be used;
- ✓ Advantages / Disadvantages of a particular program
- ✓ What can we learn by using this lesson plan (end of Appendix 2)

#### 1. Why do poverty and income inequalities matter?

The examination of poverty and income inequality is important, due to their impacts on our lives. Poverty and income inequality can lead to a widening gap between the rich and the poor, may reduce people's opportunities to study and can have negative effects on people's health.

#### 2. What topics will your students learn if the teacher uses this lesson plan?

- Visualizing
- Using Gapminder for examining a special topic
- Reflecting on context and communicating results

#### 3. Student's Pre-requisites

- The required preliminary knowledge is to have basic knowledge about the usage of Gapminder (Gapminder level 1 lesson plan)
- to know different chart types (e.g. line, bar, scatter)
- to know different functions (especially linear and log functions)
- and to know the concept of correlation or regression models.

#### 4. What program should be used for visualisation and analysis?

We have used Gapminder as the digital tool for this worksheet.

To use Gapminder, go to <http://www.gapminder.org>



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### 5. Advantages vs. Disadvantages for using Gapminder:

There are plenty of advantages for using Gapminder for this lesson plan:

- Free, browser-based, open source web application
- Educational web-based visualization tool with very spectacular solutions
- User-friendly interface
- Easy to understanding and easy to use for students with no background in statistical analysis.
- The available indicators are downloadable
- There is an option for importing data in the offline version

There are a number of disadvantages:

- Limited kinds of graphical representations
- Narrower range of indicators (compared to Eurostat or to OECD.Stat)

### 6. Where to start?

Proceed to the following pages to learn more about lesson plan about the usage of Gapminder.



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### Appendix 1: How to use Gapminder

Videos and explanations on how to get started with Gapminder and assistance for beginning users of Gapminder is available here:

<http://www.gapminder.org/downloads/>

or

<http://www.gapminder.org/videos/>

### Appendix 2: Worksheet with answers

This part of the document will provide you with worksheet with possible answers and explanations.

<i>Action/task/questions</i>	<i>Information for instructors</i>		
	<i>Operative information (Time, aim)</i>	<i>Previous knowledge (content/statistical or context)</i>	<i>Expected answer/solution</i>
Watch the wealth and health of nations in Gapminder world and answer the following questions! 1. What is being explored in this display? (What are the indicators?)	<b>Introduction block1:</b> 15-20 minutes  This block deals with the concept of income inequalities and life expectancy. With the help of this block, student can see how to interpret visualization in Gapminder in social context.	Statistical/technical knowledge: - Gapminder Level1 (how to use Gapminder) - log/lin transformations: A log scale can make it easier to see trends, and a log scale expands the scale at low values and compresses the scale at high values (Gapminder webpage).	1. What is being explored in this display? (What are the indicators?)  - We examine the relation between life expectancy and income per capita from 1800 to 2015 in several countries/geographical regions. - Note: check 'View data' icon at the bottom/left side of indicators → this is a



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<p>2. What can you state about the changes in time?</p> <p>3. Are there any regional differences? Which countries are rich?</p> <p>4. Are big (large population) countries rich?</p>		<ul style="list-style-type: none"> <li>- correlation coefficient: examine the relationship between two metric variables</li> </ul> <p>Context knowledge: (Gapminder metadata)</p> <ul style="list-style-type: none"> <li>- Life expectancy: The average number of years a new born child would live if current mortality patterns were to stay the same</li> <li>- Income per person: Gross Domestic Product per capita by Purchasing Power Parities (in international dollars, fixed 2011 prices). Inflation and differences in the cost of living between countries have been taken into account.</li> <li>- Income inequality: Income inequality is an indicator of how material resources are distributed across society (OECD 2014).</li> </ul>	<p>link to data where the definitions of indicators can be found (see previous knowledge as well)</p> <ul style="list-style-type: none"> <li>- Income per person log scale: If there is a nonlinear relation between the original variables it can be worth applying log scale. In this example the values of income per person are in relatively wide scale, and with the help of log transformation values can be seen in a narrower scale and are better comparable.</li> </ul> <p>2. What can you state about the changes in time?</p> <p>The life expectancy and the income per capita both increased over time; there was a sharp decrease in life expectancy around the world wars.</p> <p>3. Are there any regional differences? Which countries are rich?</p> <p>There are regional differences. USA, Japan, and European countries are richer, but countries in Sub-Saharan Africa are poorer.</p>
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<p>5. What is the relation between life expectancy and income per person?</p>			<p>4. Are big (large population) countries rich?</p> <p>Not always. If we consider the size of bubbles, we can see that China has a huge population and are in the first third of the ranking. BUT: India is also a country with huge population, but is only in the middle of the ranking.</p> <p>5. What is the relation between life expectancy and income per person?</p> <p>There is a positive linear relationship between the life expectancy and the (log) income per capita (there is a non-linear relationship between life expectancy and income per capita). This is true over time; however the relationship seemed to be stronger sometimes (e.g. 1930's). If a country has higher (log) income per capita, there is higher life expectancy (and vice versa).</p>
<p>Examine the relationship between extreme poverty (economy – poverty - ratio of people</p>	<p><b>Introduction block2:</b> 15 minutes</p>	<p>Statistical/technical knowledge: - same as Introduction block1</p>	<p>Examine the relationship between extreme poverty (economy – poverty - ratio of people below 3.20\$ a day) and food supply (health –</p>

<p>below 3.20\$ a day) and food supply (health – nutrition)!</p> <p>6. What can you see in the visualization? Create an analysis in a few sentences!</p> <p>7. Use the urban poverty indicator (% urban people below national urban poverty line) instead of</p>	<p>This block deals with the concept of poverty and health.</p> <p>If students do not have previous knowledge, describe the main approaches to measuring poverty.</p> <p>With the help of this visualization students</p> <ul style="list-style-type: none"> <li>- can see there are more poverty indicators/approaches</li> <li>- can see that more variables can relate to poverty (e.g. health)</li> </ul>	<p>Context knowledge (Gapminder metadata, OECD 2014, European Commission 2004, Ligeti 2016):</p> <ul style="list-style-type: none"> <li>- Poverty concept: People are said to be living in poverty if their income and resources are so inadequate as to preclude them from having a standard of living considered acceptable in the society in which they live.</li> <li>- Classifications: <ul style="list-style-type: none"> <li>o objective (measurable, indicators) and subjective(based on perception) poverty</li> <li>o one dimension (Most used dimension of poverty: very low income: Income poverty) or multi-dimensional approach (Severe deprivation of basic human needs (food, safe drinking water, sanitation facilities, health, shelter, education and information.)</li> <li>o absolute (e.g. someone cannot afford the basic necessities of life, or lives below 1.25</li> </ul> </li> </ul>	<p>nutrition)!</p> <p>6. What can you see in the visualization? Create an analysis in a few sentences!</p> <p>Aspects:</p> <ul style="list-style-type: none"> <li>- Axes: food supply – higher values mean a better situation, poverty – lower values mean a better situation</li> <li>- Time: We have a shorter time series; so it can be useful to decrease the speed of visualization. There was a slight improvement between 1978 and 2007.</li> <li>- Regional differences: African countries are in a worse situation, and European countries are in a better situation.</li> <li>- Relation: there is a negative relationship between the two variables (over the time). If the food supply is higher, poverty is lower (vice versa). There is no need for log transformation; trends can be seen and comparisons can be made with linear scales.</li> </ul>
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<p>the extreme poverty indicator (ratio of people below 3.20\$ a day)! What can you state about India's position in 2000 compared to task 1)?</p>		<p>\$ a day) and relative (Relative poverty is when a person cannot afford a living standard that is reasonable, relative to what is considered normal in the country – compares to the surrounding).</p> <ul style="list-style-type: none"> <li>- Ratio of people below 2\$ a day: Poverty headcount ratio at \$2 a day (PPP) (% of population).</li> <li>- Food supply: The total supply of food available in a country, divided by the population and 365 (the number of days in the year).</li> <li>- Urban poverty: Poverty headcount ratio at urban poverty line (% of urban population)</li> </ul>	<p>7. Use the urban poverty indicator (% urban people below national urban poverty line) instead of the extreme poverty indicator (ratio of people below 3.20\$ a day)! What can you state about India's position in 2000 compared to task 1)?</p> <ul style="list-style-type: none"> <li>- India's poverty situation was worse considering the ratio of people below 3.20\$ a day than considering the % urban people below national urban poverty line. Both of the indicators are in the topic of poverty but reflect a different picture (see Appendix Figure1, Figure2).</li> <li>- Which is the correct one? The question is inappropriate: there is no correct one, this difference show that poverty is a multi-dimensional concept and can be measured by different indicators from different approaches.</li> </ul>
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<p>8. What kind of indicators are associated most strongly with extreme poverty? Describe the relationship between the indicators!</p> <p>9. What kind of indicators are associated most strongly with income inequality index (Gini)? How? Describe the relationship between the indicators!</p> <p>10. What kind of indicators are associated most strongly with the income share of the poorest 10% of the population? Describe the relationship between the indicators!</p> <p>11. How has the relationship between extreme poverty and inequality index (Gini) changed over time? Are there any differences among countries?</p>	<p><b>Independent task solving</b> (10 minutes)</p> <p>Give the questions to students! You can give one question to one student and repeat the question or they can form groups, and each group can get a question.</p> <p>They have to use Gapminder for answering the questions. They have to show their visualization and have to interpret the visualization (as it was in Introduction block2.)</p>	<p>See previous block</p>	
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	<ul style="list-style-type: none"> <li>- Students answer the questions (20 minutes)</li> <li>- You can have about 5 minutes/each question, but fewer questions can be discussed more deeply.</li> </ul>		<p>Evaluation aspects:</p> <ul style="list-style-type: none"> <li>- Axes: What can we see? Do students name the axes</li> <li>- What kind of changes are there over time? Decrease or increase? Are there any breaks in time series?</li> <li>- Regional differences: Are there any kinds of regional differences?</li> <li>- Is there any kind of relation between the variables? Positive or negative? Log or linear?</li> </ul> <p>This list gives some of the things which will be present in good student work – you may prompt students to address these aspects if they have not done it themselves.</p>
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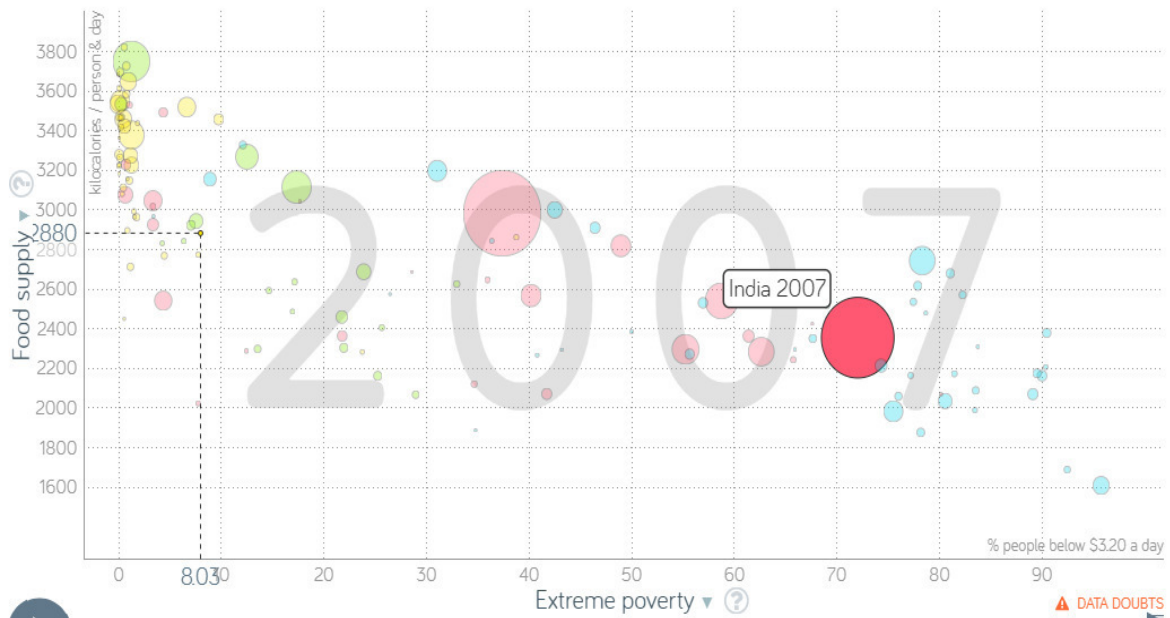
### Summary of the lesson plan

What is the message of this lesson? This lesson does not intend to evaluate our world whether it is poor or rich. But after this lesson students are going to have more information about:

- understanding statistical concepts (e.g. correlation, log transformation) better with the help of poverty indicators
- understanding the concept of poverty better
- understanding that poverty is a multi-dimensional concept. There is not “one and the best” indicator to describe poverty. Students will realize that they have to describe poverty by more indicators to have a better picture or a more complex approach about the concept.

### Appendix3 - Figures

Figure 1 India's position in 2000 considering food supply and extreme poverty  
(ratio of people below 3.20\$ a day)



Source: Gapminder.org

Figure 2 India's position in 2000 considering food supply and urban poverty (% urban people below national urban poverty line)



Source: Gapminder.org



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### Why do poverty and income inequalities matter?

The examination of poverty and income inequality is important, due to their impacts on our lives. Poverty and income inequality can lead to a widening gap between the rich and the poor, may reduce people's opportunities to study and can have negative effects on people's health.

### What is Gapminder?

Gapminder is a visualization tool which can support a better understanding of social and economic phenomena and of the usage and background of various statistical methods.

To describe social phenomena, statistical data and its visualization have a key role. Gapminder offers several possibilities for visualizing data, and learning how to use it can support you in understanding complex social phenomena.

### More Background

For more information, visit the following website

<http://www.gapminder.org/>

### Data Source

Considering the datasets, there are 17 indicators in Gapminder World, provided by The World Bank (14) and Forbes (3), within the topic of poverty and income inequalities. Gapminder Documentation describes the methods, sources and data used to produce the various datasets of Gapminder. The data itself is available through excel files.

Consider the technology and the software; we can use either the online or the offline version of Gapminder in this level. The offline version and data used by Gapminder are downloadable. In the online interface, Gapminder has spectacular dynamic visualization tools. Gapminder World has a bubble chart which can show the change of two indicators in time; and there is also possibility to colour the visualization by other grouping variables or indicators, and use the bubble size to show population size.



To start, click here

[https://www.gapminder.org/tools/#\\_chart-type=bubbles&locale\\_id=en](https://www.gapminder.org/tools/#_chart-type=bubbles&locale_id=en)

## Tasks:

### Introduction

Watch the wealth and health of nations in Gapminder world and answer the following questions!

1. What is being explored in this display? (What are the indicators?)
2. What can you state about the changes in time?
3. Are there any regional differences? Which countries are rich?
4. Are big (large population) countries rich?
5. What is the relation between life expectancy and income per person?

Examine the relationship between extreme poverty (economy – poverty - ratio of people below 3.20\$ a day) and food supply (health – nutrition)!

6. What can you see in the visualization? Create an analysis in a few sentences!
7. Use the urban poverty indicator instead of (% urban people below national urban poverty line) instead of extreme poverty (ratio of people below 3.20\$ a day)! What can you state about India's position in 2000 compared to task 1)?

### Exploration and discussion

8. What kind of indicators are associated most strongly with extreme poverty? Describe the relationship between the indicators!
9. What kind of indicators are associated most strongly with the income inequality index (Gini)? How? Describe the relationship between the indicators!
10. What kind of indicators are associated most strongly with the income share of the poorest 10% of the population? Describe the relationship between the indicators!
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