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PÄDAGOGISCHE HOCHSCHULE TIROL

JKU
JOHANNES KEPLER UNIVERSITY LINZ

Technology changing statistics education

Defing possibilities, opportunities and obligations

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What is statistics?

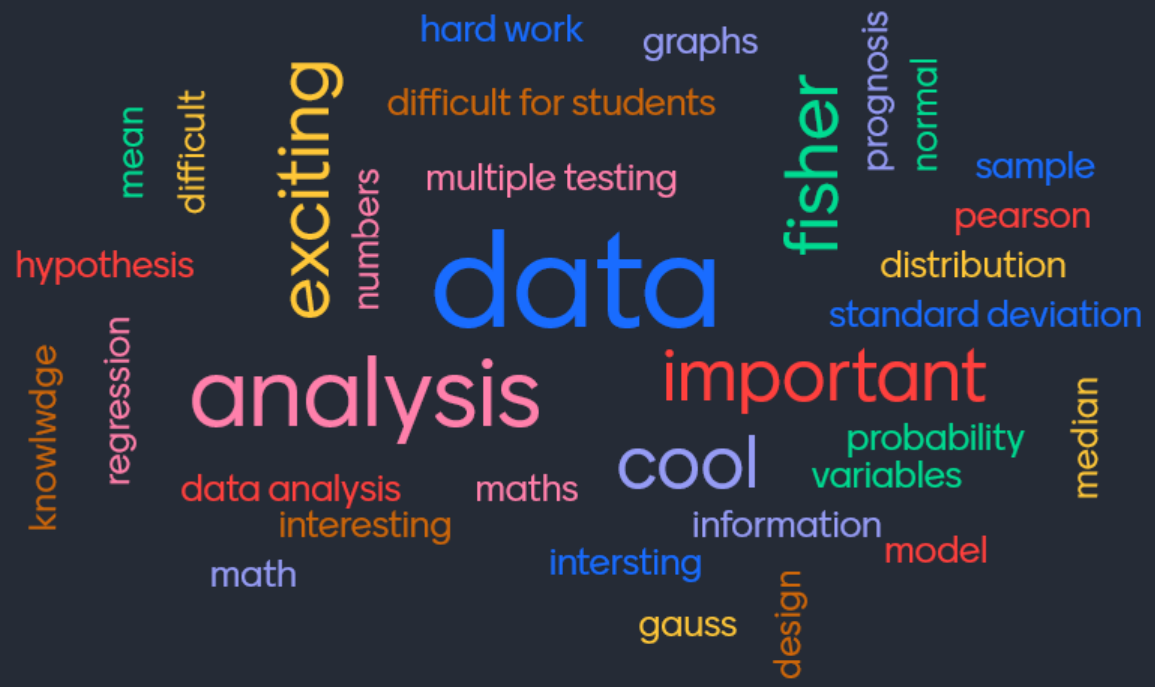
Please, visit
menti.com
and enter the code 73 25 29 0.

You can also use the QR-code with your mobile phones.

What is statistics?

Mentimeter

What comes to your mind thinking of statistics? Please, name 3 words.



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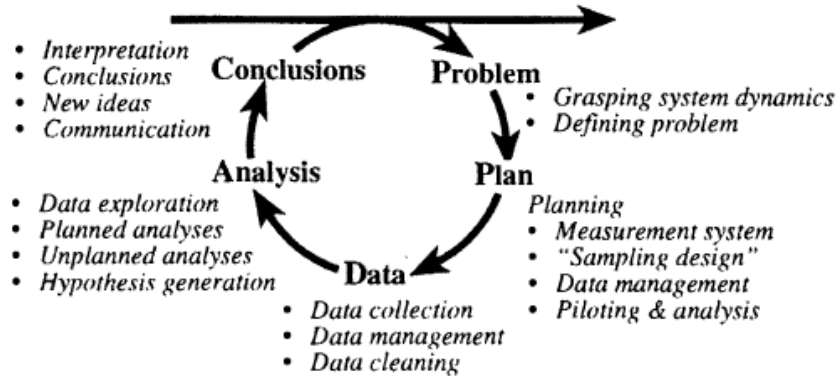
What is statistics?

(a) DIMENSION 1 : THE INVESTIGATIVE CYCLE

(PPDAC)



(b) DIMENSION 2 : TYPES OF THINKING

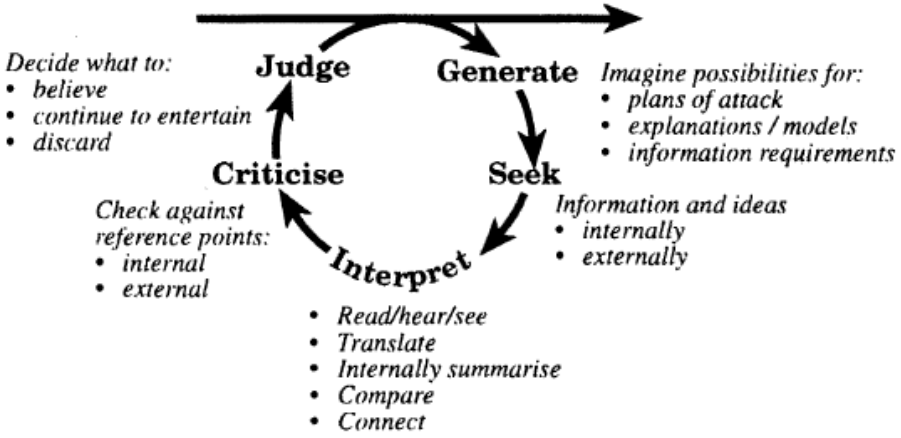
GENERAL TYPES

- **Strategic**
  - — planning, anticipating problems
  - — awareness of practical constraints
- **Seeking Explanations**
- **Modelling**
  - — construction followed by use
- **Applying Techniques**
  - — following precedents
  - — recognition and use of archetypes
  - — use of problem solving tools

TYPES FUNDAMENTAL TO *STATISTICAL* THINKING (Foundations)

- **Recognition of need for data**
- **Transnumeration**
  (Changing representations to engender understanding)
  - — capturing "measures" from real system
  - — changing data representations
  - — communicating messages in data
- **Consideration of variation**
  - — noticing and acknowledging
  - — measuring and modelling for the purposes of prediction, explanation, or control
  - — explaining and dealing with
  - — investigative strategies
- **Reasoning with statistical models**
- **Integrating the statistical and contextual**
  - — information, knowledge, conceptions

(c) DIMENSION 3 : THE INTERROGATIVE CYCLE



(d) DIMENSION 4 : DISPOSITIONS

- **Scepticism**
- **Imagination**
- **Curiosity and awareness**
  - — observant, noticing
- **Openness**
  - — to ideas that challenge preconceptions
- **A propensity to seek deeper meaning**
- **Being Logical**
- **Engagment**
- **Perseverance**

4 dimensional framework for statistical thinking in empirical enquiry by Wild & Pfannkuch (1999), p. 226

What is statistics?

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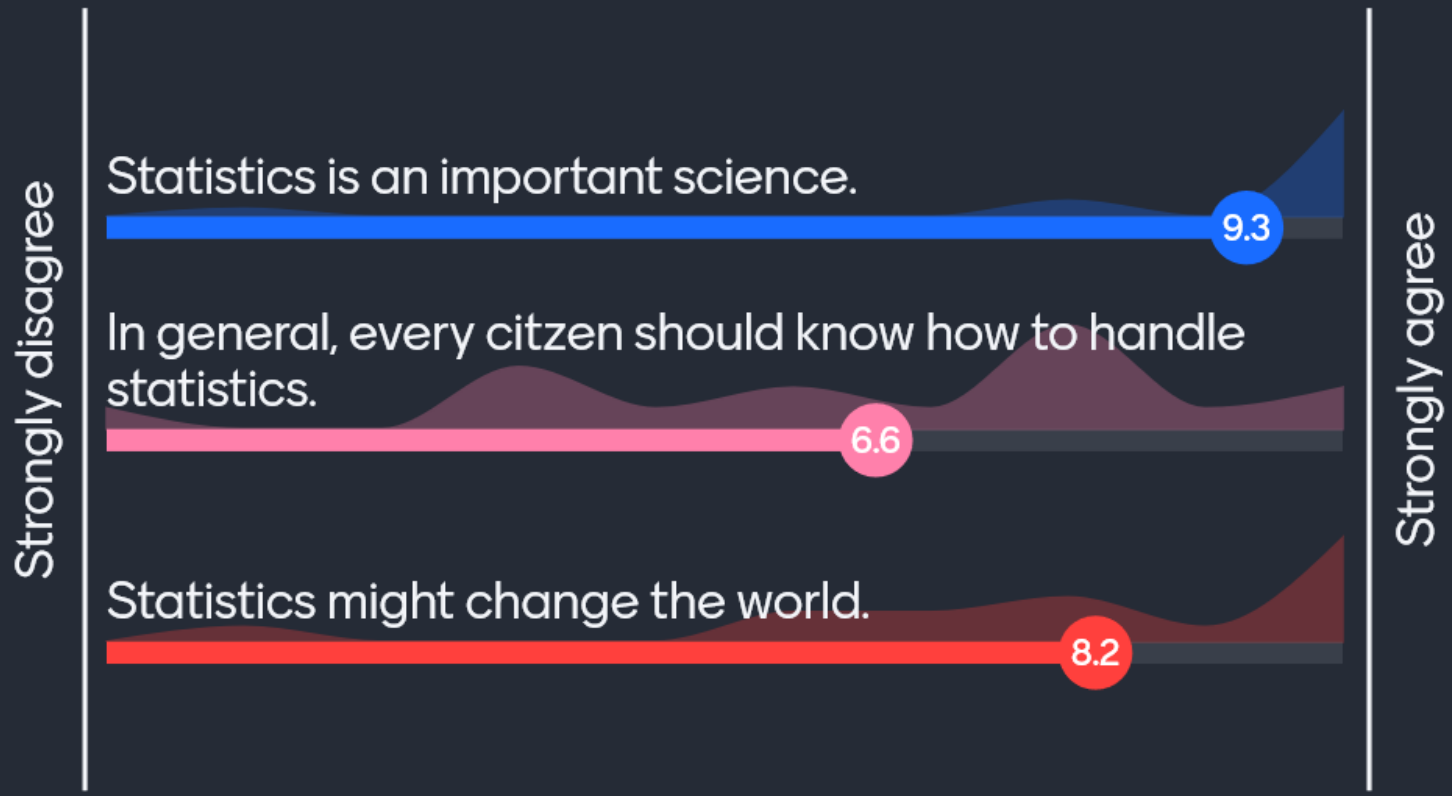
What is statistics?

Scales

Mentimeter



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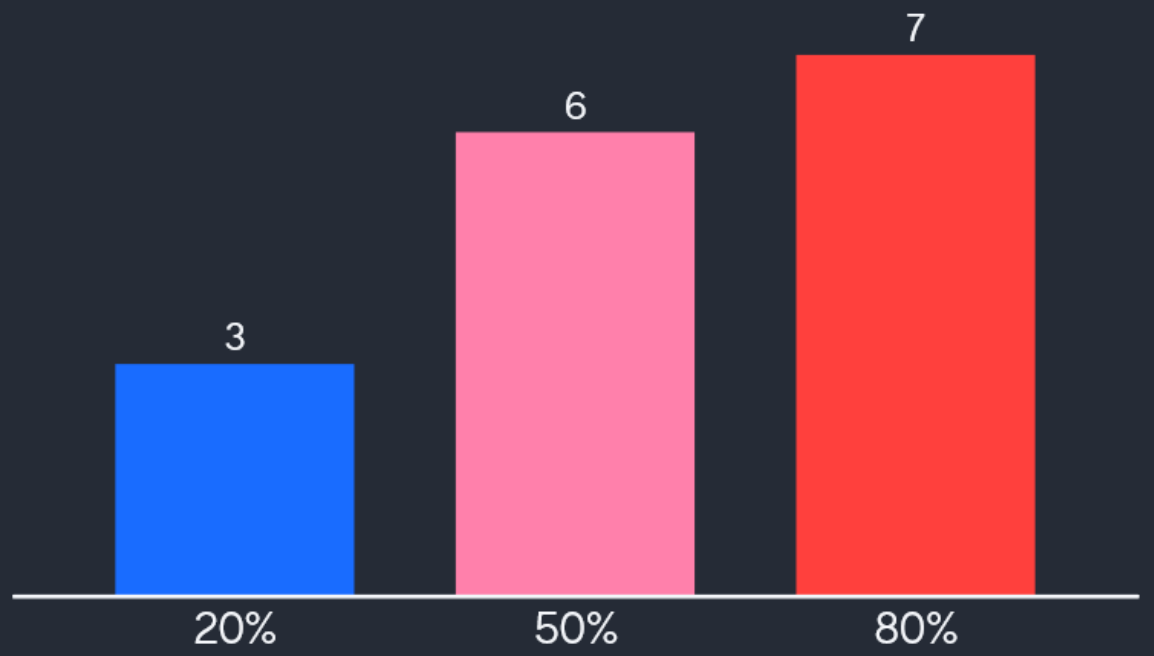
What is statistics?

How many children worldwide are vaccinated against measles?

Mentimeter



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What is statistics?

- Founder of the Gapminder Foundation and Gapminder Software
- Inventor of the project *Factfullness*
- Researcher and Edutaner
- Film maker (e.g., The joy of stats retrieved from https://www.gapminder.org/videos/the-joy-of-stats/)

"[…] citizens need to understand statistics about past trends, present situations, and possible future changes in diverse areas of importance to society such as demographics, employment, wages, […] and other domains" (Nicholson et al., 2018, p. 2).

What is statistics education?

- GAISE College Report: Curriculum for many states in the US based on Wild & Pfannkuch (1999)
- Curriculum for Mathematics and Statistics (!) in New Zealand (here level 2 for 12yo students)

Statistics

Statistical investigation

Conduct investigations using the statistical enquiry cycle:

- posing and answering questions
- gathering, sorting, and displaying category and whole-number data
- communicating findings based on the data.

Statistical literacy

- Compare statements with the features of simple data displays from statistical investigations or probability activities undertaken by others.

Probability

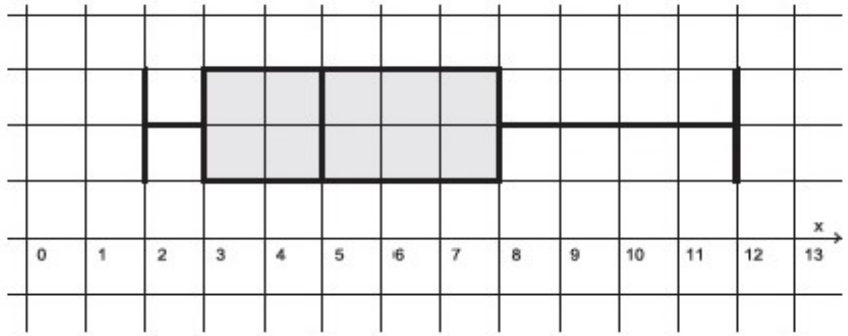
- Investigate simple situations that involve elements of chance, recognising equal and different likelihoods and acknowledging uncertainty.

NZ curriculum for mathematics and statistics retrieved from https://nzcurriculum.tki.org.nz/The-New-Zealand-Curriculum/Mathematics-and-statistics/Achievement-objectives

What is statistics education in Austria?

Boxplot

Aus einer geordneten Liste von 10 Daten wurde der nachstehende Boxplot erstellt.



Welche der Listen liegt diesem Boxplot zugrunde? Kreuzen Sie die zutreffende Liste an!

2; 2; 2; 2; 4; 5; 6; 7; 8; 9; 12; 12	☐
2; 2; 3; 3; 4; 6; 6; 7; 8; 9; 12; 12	☐
2; 2; 2; 3; 4; 4; 6; 7; 9; 9; 12; 12	☐
2; 2; 2; 3; 4; 4; 6; 7; 8; 8; 12; 13	☐
1; 2; 2; 3; 4; 4; 6; 7; 8; 9; 12; 12	☐
2; 2; 3; 3; 3; 5; 5; 7; 8; 8; 12; 12	☐

Finding relations between a boxplot and the according dataset (BIFIE (Ed.), 2013, p. 53).

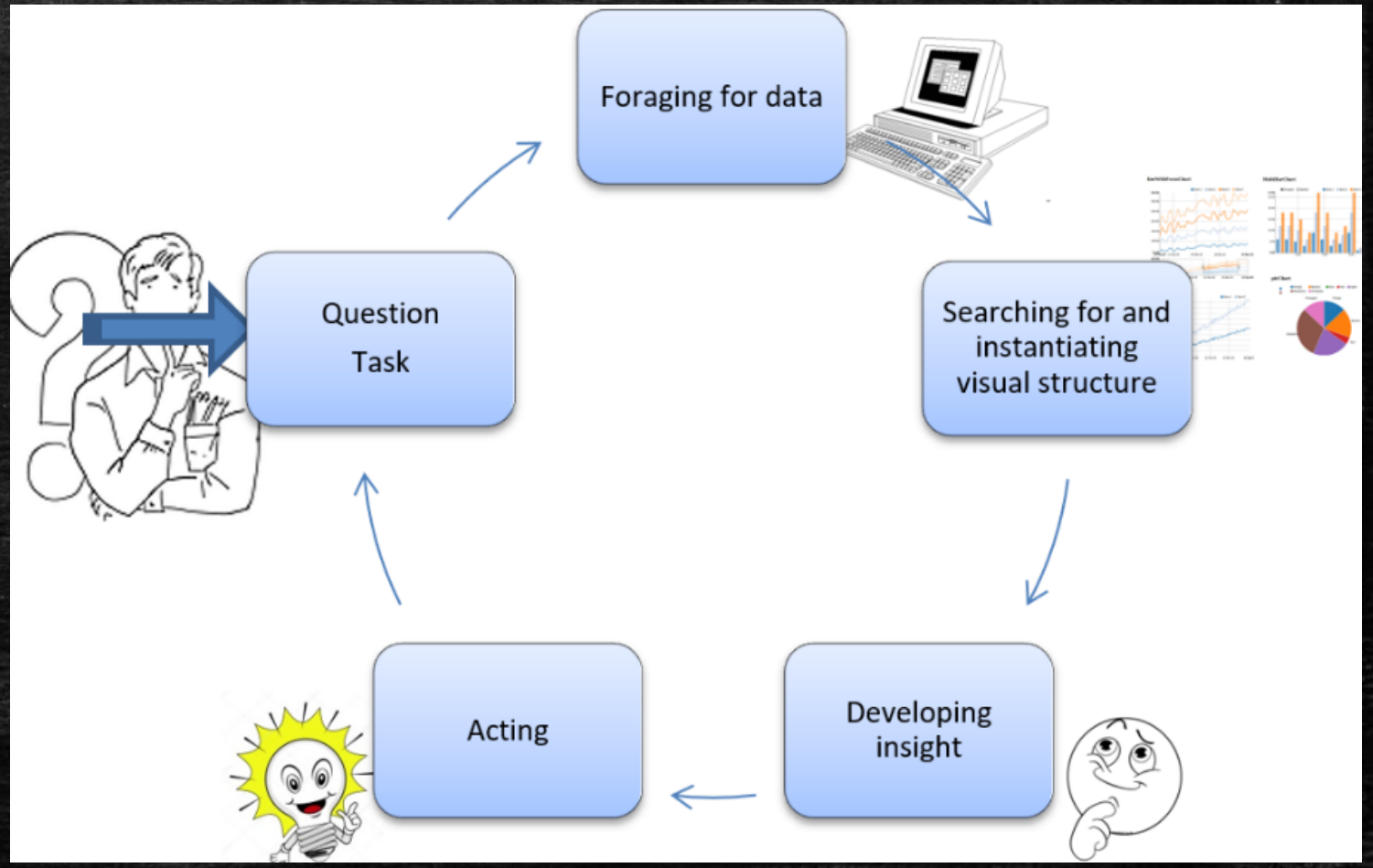
What is statistics education in Austria?

Grade	Students …
5	- can use tables and graphs to collect data.
6	- can determine relative frequencies; read, produce, and critically reflect the corresponding graphical representations; know possibilities of manipulation.
7	- can examine and display datasets.
8	- can examine and display datasets using statistical measures (e.g., mean, median, quartile, relative frequency, scatterplots).
9	No topics of probability theory or statistics
10	- know and work with statistical measures and visualisations of descriptive statistics - know the relationship between relative frequency and probability
11	- can work with discrete distributions (especially with the binomial distribution) in application-oriented areas
12	- can use the normal distribution in application-oriented areas - determine and interpret confidence intervals - do simple statistical hypothesis testing, including interpretations of the results

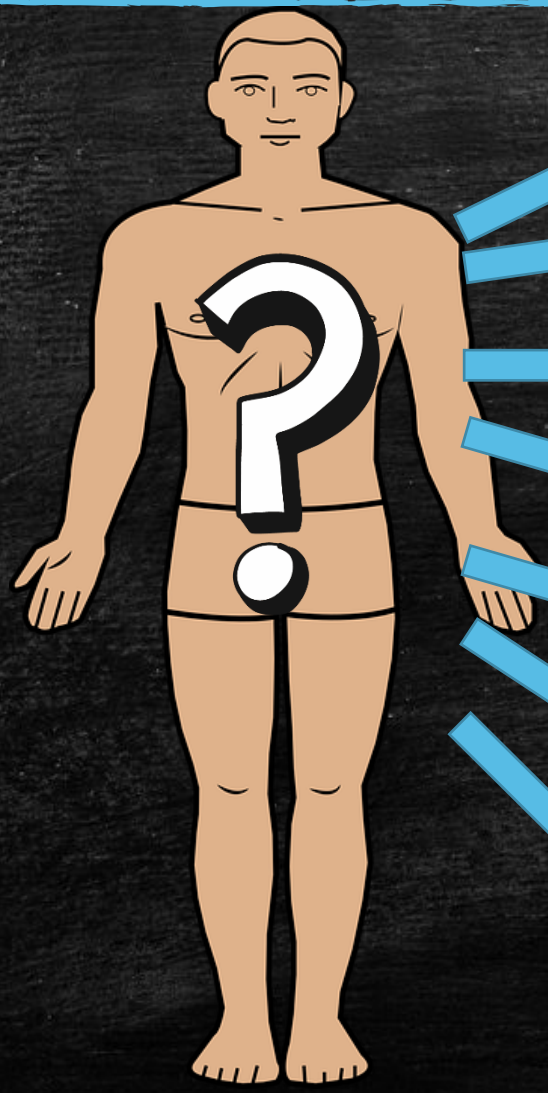
Tab 1: Austrian curriculum of mathematics concerning statistics and the probability theory (BGBl. II Nr. 283/2003)

Visual statistics

- Cycle of inquiry and visual analysis (Prodromou, 2014)



Statistical modelling



Weight

Size

Body Mass Index

Age

Haircolour

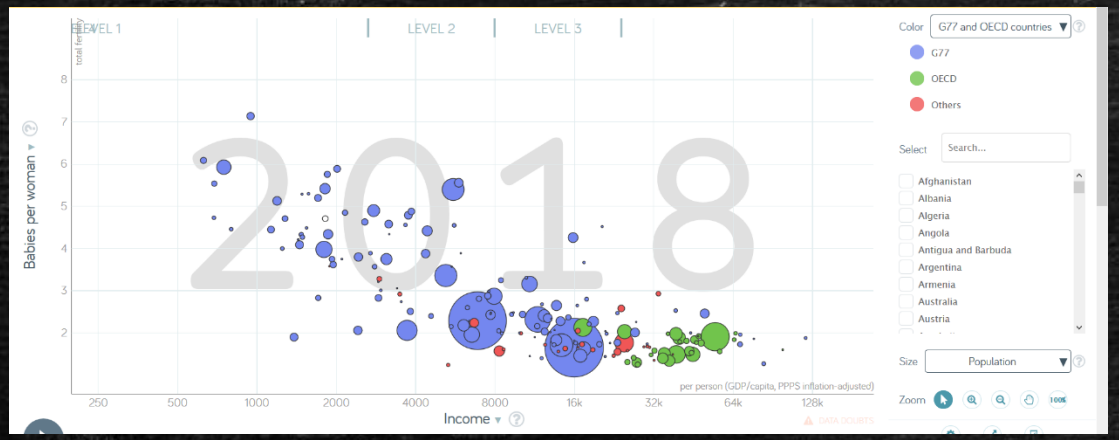
Legs

...

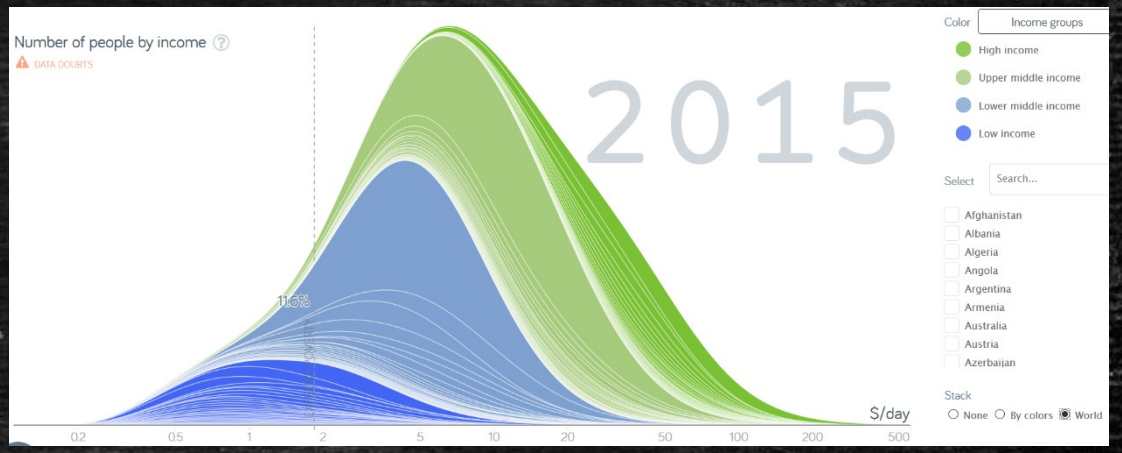
„Conceiving Statistics as Forming Models: The ability to use statistical models to describe a wide range of phenomena in our world and quantify an aspect of these phenomena is important. […] Modelling activities are likely to increase students‘ understanding of how science and statistics are connected when all phenomena are modelled via mathematics.“ (Prodromou & Dunne, 2017, p.20)

Intuitions in statistics education

Formalizing students' informal statistical reasoning on real data:
Using Gapminder to follow the cycle of inquiry and visual analyses.



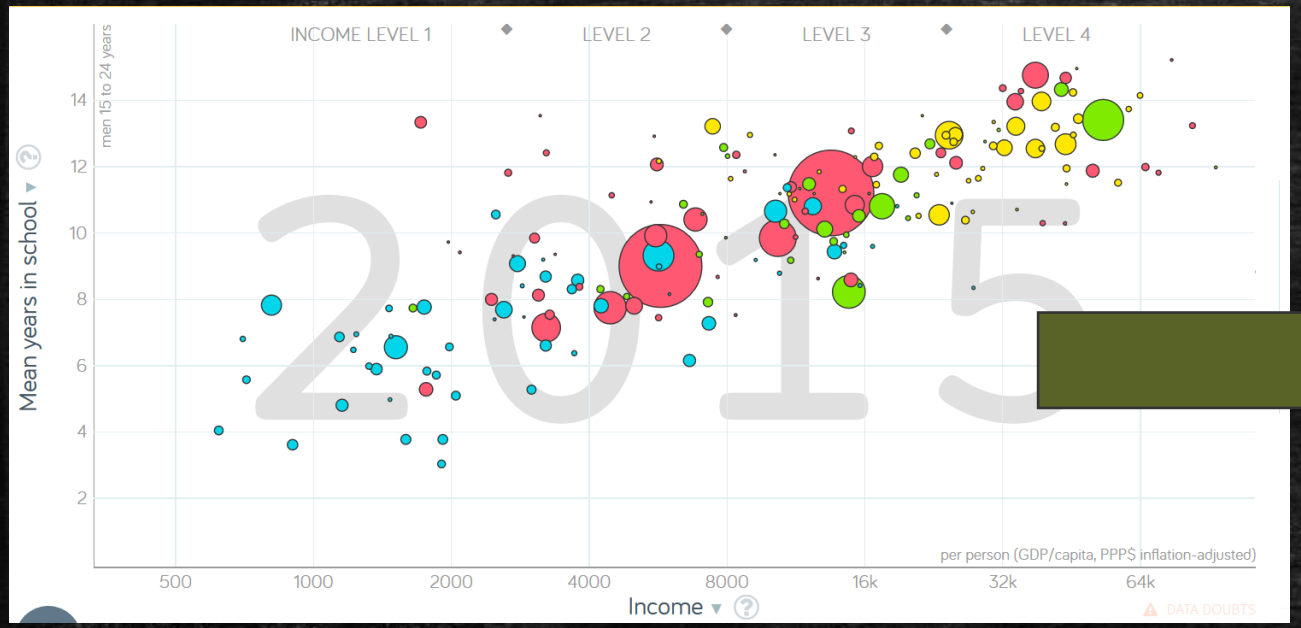
Idea of covariation

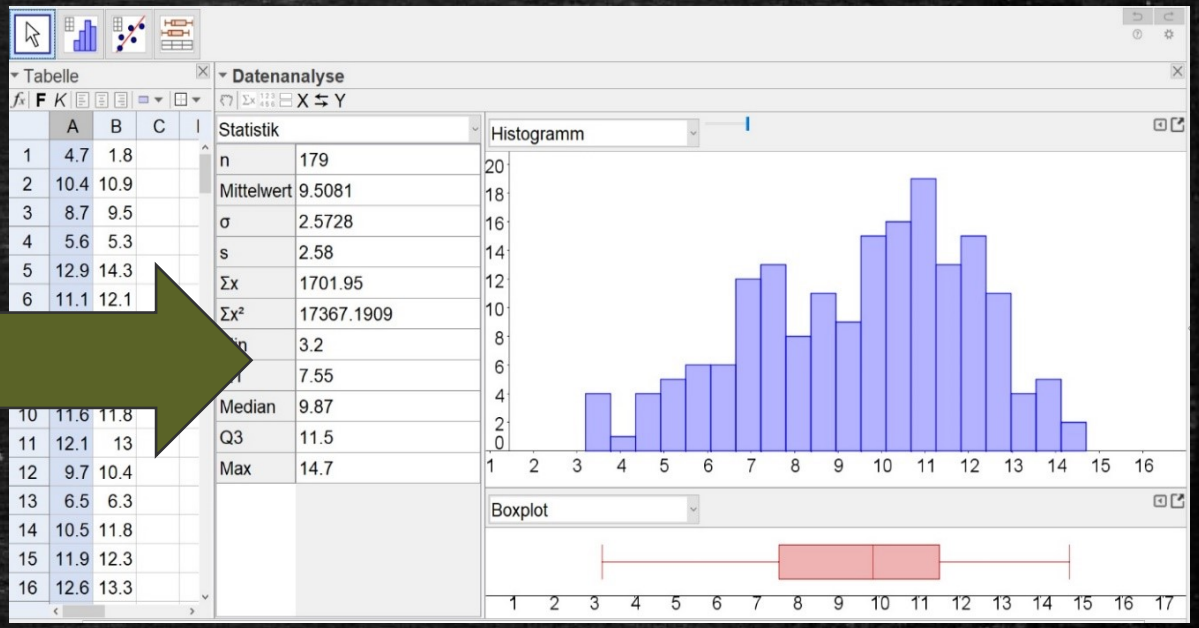


Idea of centre and spread

Andre, M., Lavicza, Z., & Prodromou, T. (2019). Formalizing students informal statistical reasoning on real data: Using Gapminder to follow the cycle of inquiry and visual analyses. In U. T. Jankvist, M. van den Heuvel-Panhuizen, & M. Veldhuis (Eds.), *Proceedings of the Eleventh Congress of the European Society for Research in Mathematics Education* (pp. 870-877). Utrecht, the Netherlands: Freudenthal Group & Freudenthal Institute, Utrecht University and ERME.

Working with data in GeoGebra





Transferring data from Gapminder to GeoGebra/SPSS

Andre, M., Lavicza, Z., & Prodromou, T. (2019). Die Relevanz von Armut: Kritisches Denken durch Visualisierung sozial- und wirtschaftspolitischer Daten mit Gapminder entwickeln [The relevance of poverty: A project to develop critical thinking by visualizing social and economic data with Gapminder]. *Transfer Forschung <-> Schule*, *5*, 139-147.

"You don’t listen to the science because you are only interested in solutions that will enable you to carry on like before. Like now. And those answers don’t exist any more. Because you did not act in time.“
(Thunberg, G., 04/2019, Houses of Parliament)

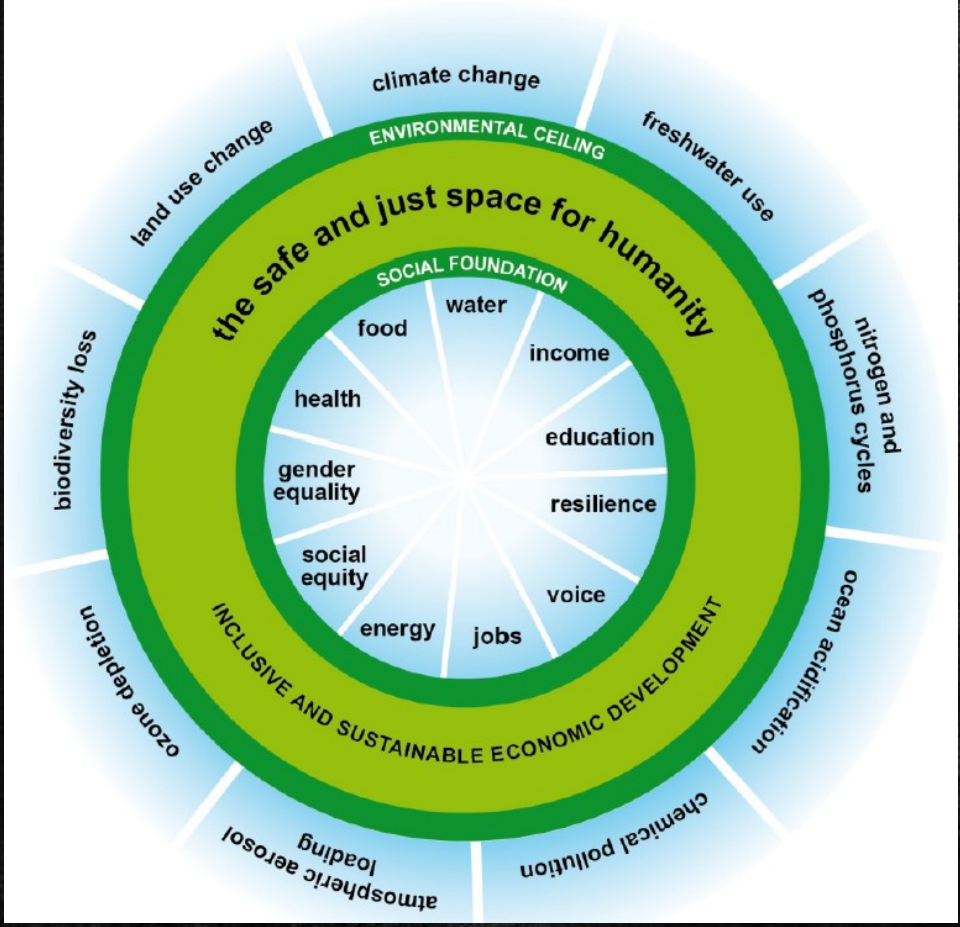
Theoretical background

ESD

Figure: https://en.wikipedia.org/wiki/File:Sustainable_Development_Goals_chart.svg

„ESD aims at developing competencies that empower individuals to reflect on their own actions, taking into account their current and future social, cultural, economic and environmental impacts, from a local and a global perspective.“ (UNESCO, 2017, p.7)

Theoretical background ESD

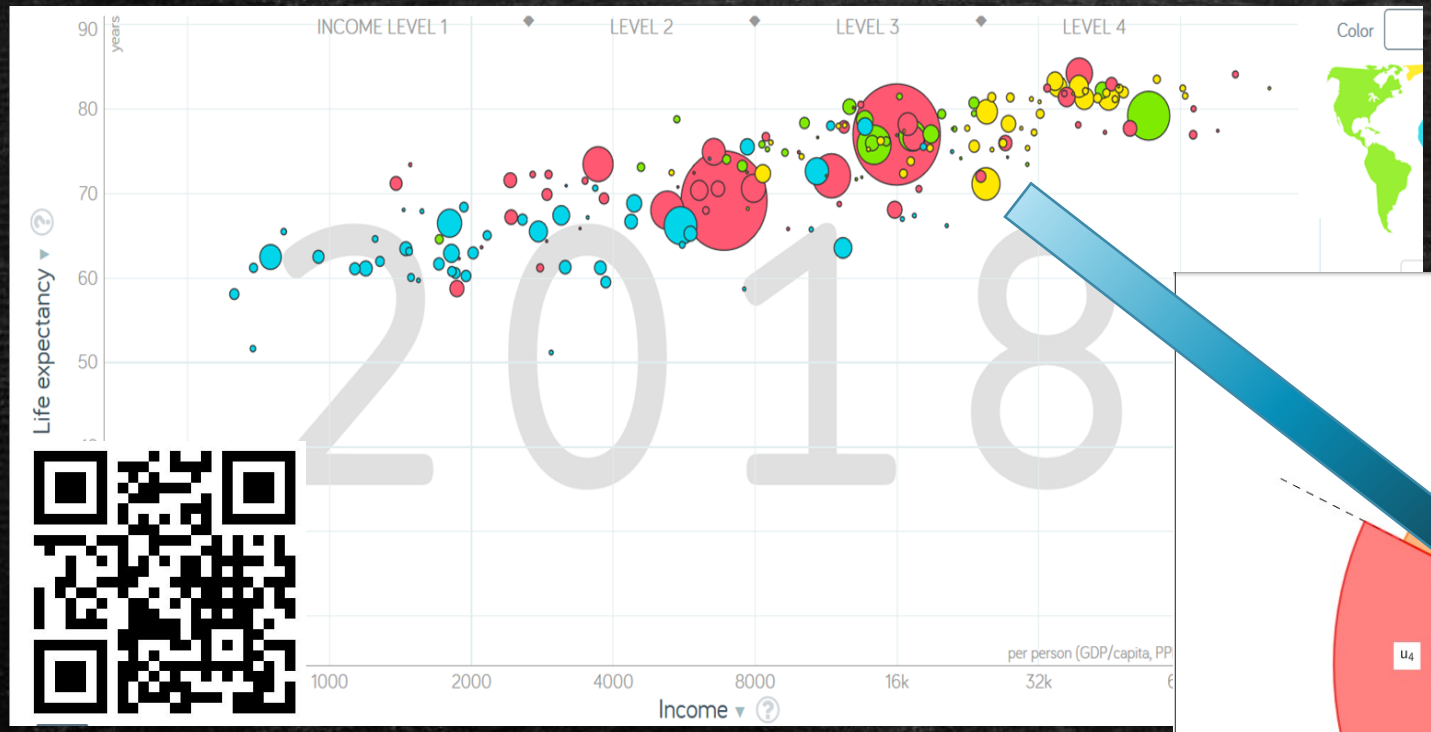


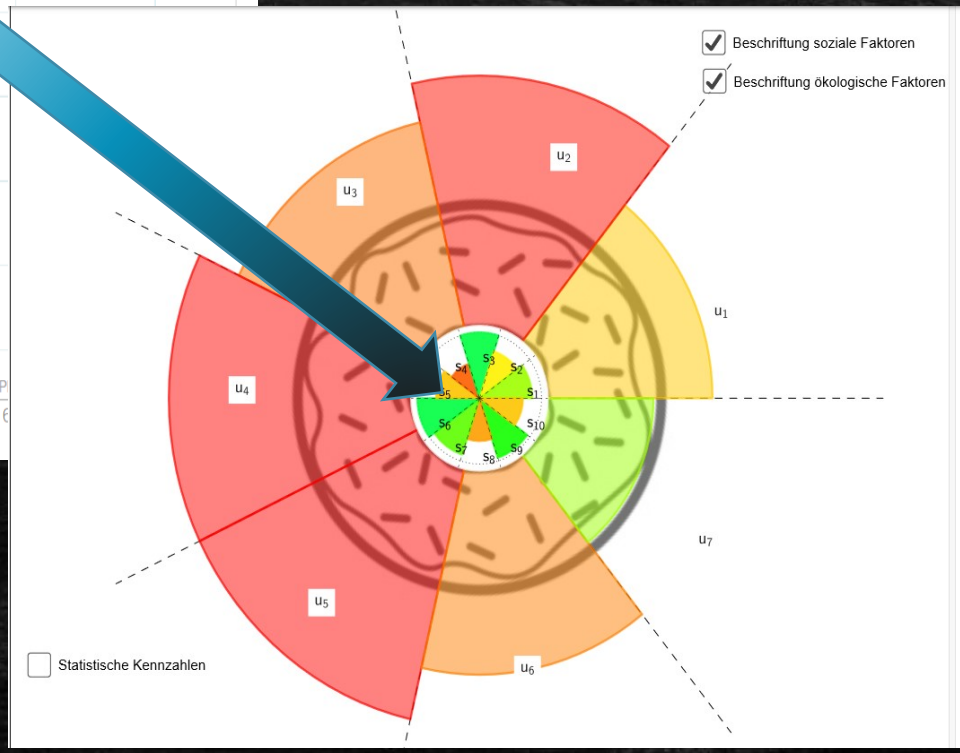
Raworth, 2017, Donought-Economy

O'Neill et al., 2018, https://goodlife.leeds.ac.uk/countries/

Graphical excellence is that which gives to the viewer the greatest number of ideas in the shortest time with the least ink in the smallest space.” (Tufte, 1983, p. 51).

Implementation ESD





"Visualization in moving graphics is an intuitive method for understanding relationships and it is an excellent way to exhibiting patterns." (Rosling et al., 2005, p. 525)

Outcomes of our research

- Data of familiar context -> Intuitive approaches to statistical concepts
- Process of statistical modelling -> Generating statistical questions
- Covariational thinking (scatterplots) <-> Systems thinking competency (Rieckmann, 2018)

Literature

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