

Activities for promoting civic statistical knowledge of preservice teachers

The course „Statistical literacy in mathematics classroom“ for mathematics preservice teachers for secondary school

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- Introduction: Civic statistics & Situation at the University of Paderborn (UPB)
- **Our Course and our activities on Civic Statistics at UPB**
 - Design of the course
 - Realization
 - Activity on course tasks
 - Experiences
 - Evaluation

Introduction:

Civic statistics & Situation at the University of Paderborn

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Introduction

- *Civic statistics* are statistics about key phenomena in society such as employment, health, education, social welfare, or inequality (Ridgway, 2015; Engel, Gal & Ridgway, 2016)
 - Decisions in politics, society and economy are often based on *civic statistics*.
-
- Responsible citizens need statistical skills and knowledge to establish critical thinking when being confronted with statistical texts and displays in the media.
 - Process of enhancing critical thinking should already start in school education, but – since even teaching the traditional contents of statistics is challenging for teachers – teachers need a more focused education on civic statistics and also how to implement civic statistics in school.

The project ProCivicStat, funded by the ERASMUS+ program of the European Commission, aims at supporting teachers with specific courses, materials, tools, and datasets for civic statistics.

Situation at the University of Paderborn:

- Compulsory course on elementary statistics and probability and compulsory course on didactics of statistics in their bachelor studies
- Master studies: preservice teachers can choose a seminar to deepen and expand their knowledge they have gained in the compulsory courses.

Goal:

→ Design a course “Statistical literacy in mathematics classroom” embedded in the ProCivicStat project to develop the statistical content and pedagogical content knowledge of our preservice teachers.

→ A focus of this course is on promoting critical statistical thinking, so that future teachers have a sustainable content knowledge, pedagogical content knowledge and a positive stance towards civic statistics to bring these issues into classroom at school.

General information on the course

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- Course „Statistical literacy in mathematics classroom“ at Paderborn University in Winter term 2016/2017
- Seminar with 21 participants
 - Preservice teachers for mathematics in lower secondary school
 - Preservice teachers at the end of their studies, having successfully attended to a course „Elementary statistics“ and „Didactics of statistics“
- 15 sessions (90 minutes each)
- Idea to build on their pre-knowledge and develop statistical content and statistical pedagogical content knowledge of participants → especially in regard to critical thinking

Design of course

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Learning goals

- **With regard to statistical content knowledge**
 - to deepen students' knowledge about reading and interpreting summary statistics and graphical displays (also in the sense of *reading beyond data* of Friel, Curcio & Bright, 2001)
 - to introduce students into statistical concepts and constructs (like correlation and causality, or Simpson's paradox) relevant in civic statistics
 - to introduce into the definition and operationalization of concepts like unemployment
 - to explore multivariate datasets on the base of given and self-generated statistical questions.
- **With regard to the pedagogical content knowledge**
 - to consider contents in civic statistics across subjects,
 - to get to know relevant material (articles, homepages, tools, datasets, etc.)
 - to learn to “simplify” complex situations in civic statistics for use in classrooms
 - to develop ideas for implementing civic statistics activities in classrooms.



Major idea of our course

Preservice teachers apply their previous gained knowledge about these statistical constructs and phenomena in more complex tasks and in project works related to specific issues of civic statistics (like poverty, unemployment, health, education, etc.).

So we want...

- confront the participants with social phenomena in Germany and Europe (e.g., gender pay gap)
- ask them to critically explore the topic taking into account investigations starting with reports in the media, real and multivariate data from statistics bureaus
- using digital tools for data exploration.

Types of sessions – Overview

- Four types of sessions in our seminar:
 - **Teacher/Lecturer centered presentations**
 - Lecturers give presentations to introduce students into specific topics (session 1 + 2)
 - **Sessions with students presentations**
 - Students (as *session leaders*) are responsible of one specific session (session 4-9)
 - **Working sessions**
 - Students working on single activities (e.g. Exploring data with Fathom, single activity tasks) (session 3, 14-15)
 - **Project sessions**
 - Students working on a specific and complex project (Gender Pay Gap project – session 10-13)



Design principles of our course – SRLE

Statistical Reasoning Learning Environment (Garfield & Ben-Zvi, 2008, p. 48)

1. Focuses on developing **central statistical ideas** rather than on presenting set of tools and procedures.
2. Uses **real and motivating data sets** to engage students in making and testing conjectures.
3. Uses **classroom activities** to support the development of students' reasoning.
4. Integrates the use of appropriate **technological tools** that allow students to test their conjectures, explore and analyze data, and develop their statistical reasoning.
5. **Promotes classroom discourse** that includes statistical arguments and sustained exchanges that focus on significant statistical ideas.
6. Uses **assessment** to learn what students know and to monitor the development of their statistical learning as well as to evaluate instructional plans and progress.

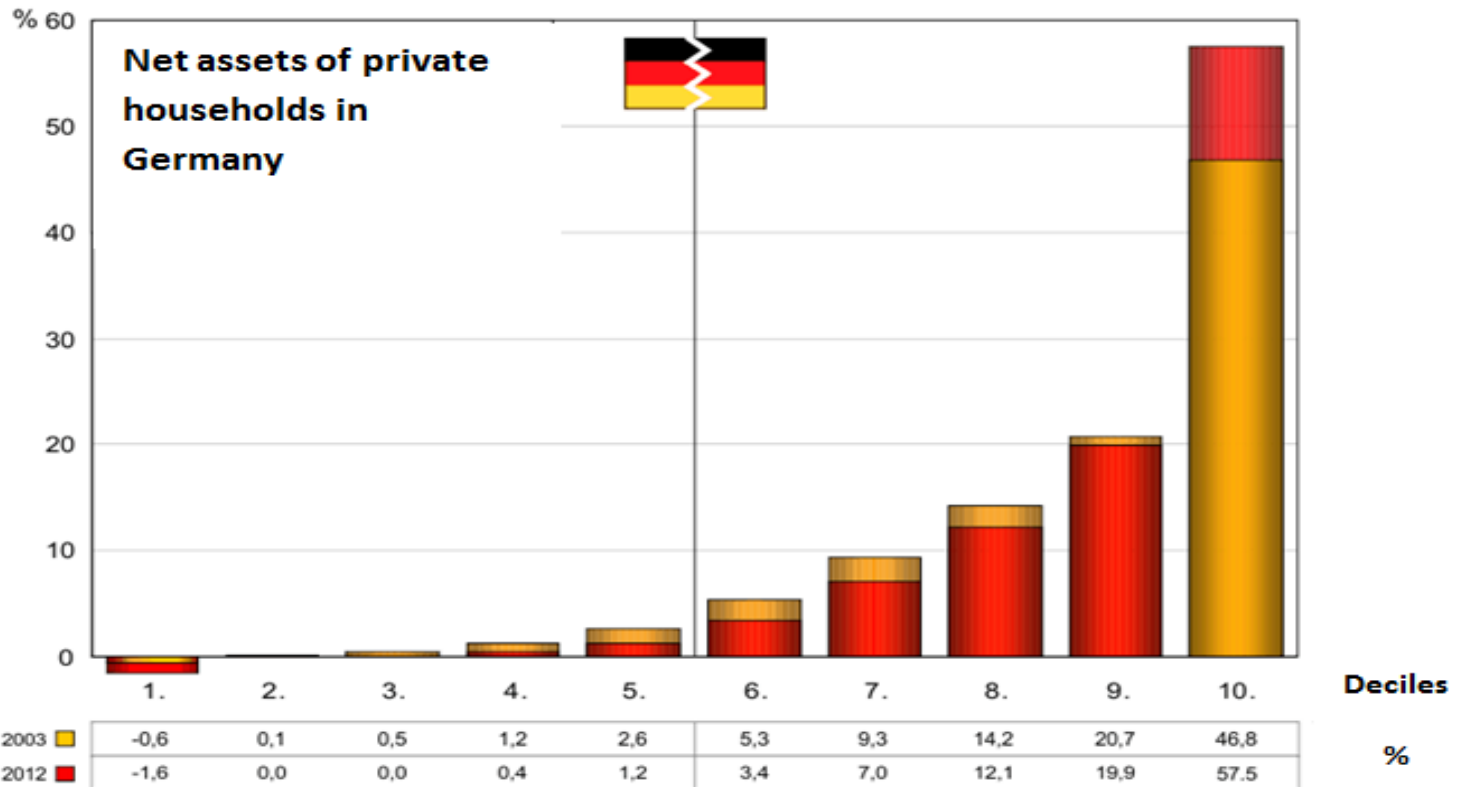
Realization of the course

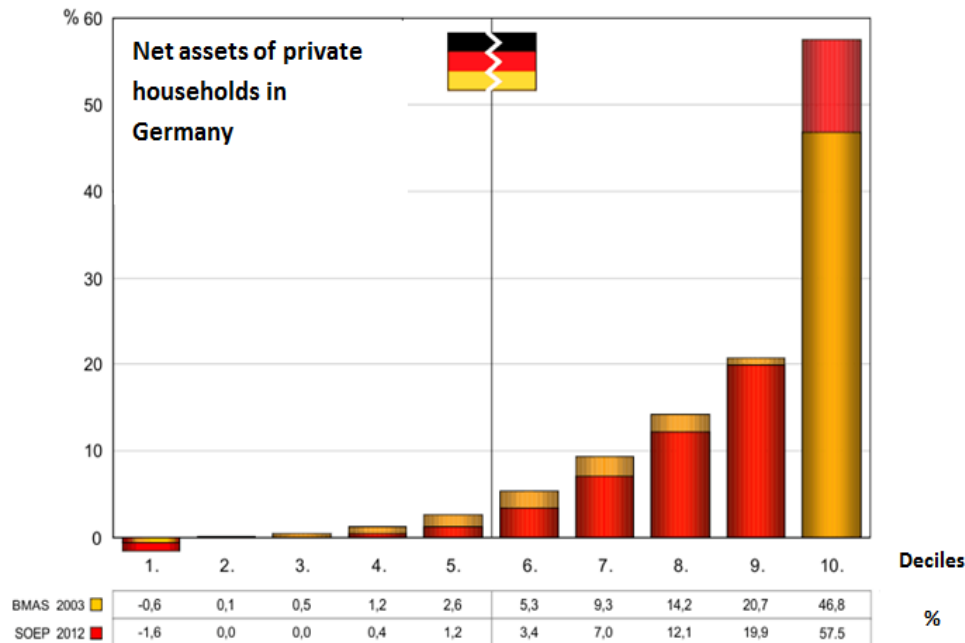
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Sessions 1 & 2

- We started the course immediately with an activity (understanding complex graph on the distribution of net assets in Germany) to introduce the participants into civic statistics
- → Goal: directly engage students with civic statistics context
- **Task for the participants:** *Interpret this statistical display in the context of inequality in German net assets.*





- The graph shows the distribution of net assets in German households in 2003 (yellow bars) and 2012 (red bars), divided into ten deciles ordered ascending from left to right.
- It is interesting that in most deciles the yellow bars are higher than the red bars, but for the tenth decile it is the other way round: the rich people got even richer in the survey of 2012 compared to 2003.
- So there is a big difference in net assets between 90 percent of the German population and the richest 10 percent.



Sessions 1 & 2

This task was very challenging for our students

→ Our participants have to...

- ...understand the definition of net assets and household
- ...know about deciles
- ...have to compare two overlapping bar graphs showing the growing inequality between 2003 and 2012 as a slightly kind of display taken from a media report.



Session 3: Exploring data with Fathom

Goal

- Refresh the statistical technological Fathom knowledge by letting the students explore a multivariate dataset on leisure time activities of German 11th grade students.

Task for participants

- Work in pairs to investigate in which way boys and girls differ in interest (e.g., in playing games on the computer).



Session 4-9: Topics for students sessions

- **Session 4: Representation of data**
- **Session 5: Percentages**
- **Session 6: Percentages II (with conditional probability)**
- **Session 7: Correlation & Causation**
- **Session 8: Simpsons Paradox**
- **Session 9: The concept of Unemployment**

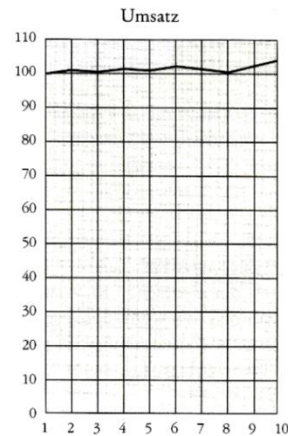
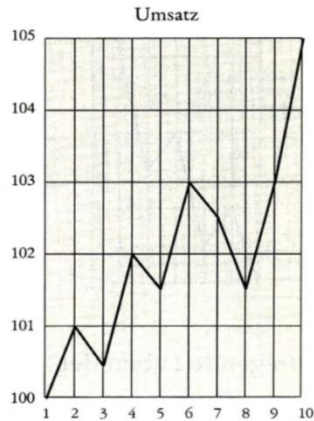


Session 4-9: Students' sessions

Common structure of all Students' sessions (Overall: 90 Minutes)

- Introduction (based on pre-given literature) **5 Minutes**
- Presentation by session leaders
 - Refreshing relevant statistical knowledge **10 Minutes**
 - Providing examples for theme (from newspapers, etc.) **15 Minutes**
- Working phase (small group activity for all students) **30 Minutes**
- Discussing results **20 Minutes**
- Reflection of session (by evaluation form) **10 Minutes**

Session 4-9: Pregiven literature



vgl. Krämer, 2007, S. 38f



Article1: Bald-head as career boost



Albert E. Mannes is a US scientist and bald head. In a study, he now wants to demonstrate that bald-shaved chicks have better chances in the job: they are considered bigger and stronger than they are. In the interview, he says, why not every careerist should take a shave

	Saxony			Bavaria		
	Average Gymnasium	Average no Gymnasium	Average all	Average Gymnasium	Average no Gymnasium	Average all
Mathematics	599	487	523	608	489	522
Science	619	504	541	619	500	533
Reading	587	477	512	598	478	511

Gender Pay Gap project (Session 10-13)



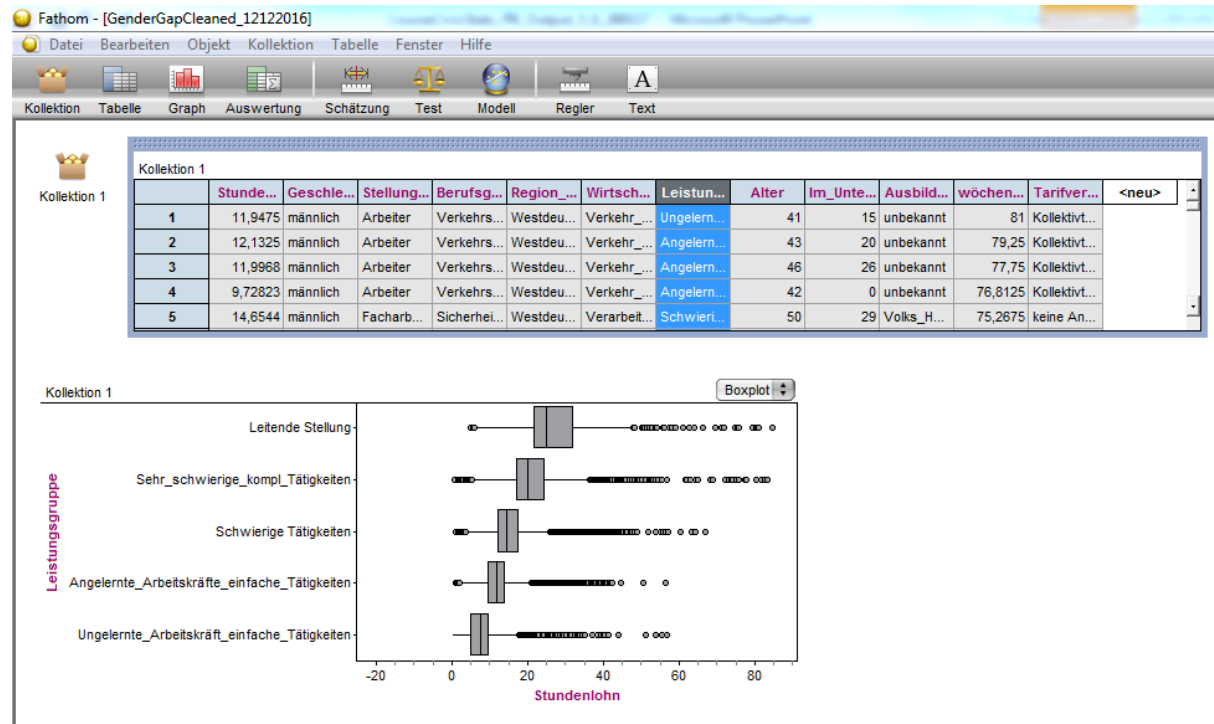
Session 10-13

Gender Pay Gap project

Learning goals of Gender Pay Gap project:

- get insight into some of the causes of the unequal pay situation between male and female employees in Germany,
- become familiar with the concept of gender pay gap and to be able to distinguish between the adjusted and unadjusted gender pay gap,
- explore the *German income structure* data set,
- learn to reflect media reports on gender pay gap critically and relate them to their own analyses,
- prepare their results and findings as PowerPoint presentations for their classmates

Exploring the Gender Pay Gap data in Peers with Fathom





Session 10-13

Gender Pay Gap project

Four sessions dedicated to Gender Pay Gap project

- Session 10 (GPG 1): Investigation on newspaper articles & background literature (Preparation)
- Session 11 (GPG 2): Explore data with tools in pairs
- Session 12 (GPG 3): Explore data with tools in pairs
- Session 13 (GPG 4): Present findings to colleagues (using PowerPoint presentation)



Gender Pay Gap project

Dataset & Dossier



Dataset VSE_2006

- exported from the German Bureau of Statistics
- ~ 60,000 cases
- employees from all levels regarding variables such as gender, wage per month, kind of employment agreement, etc.



Session 10-13

Gender Pay Gap project

Five topics (according to variables of dataset)

- Topic 1: Profession
- Topic 2: Function (simple to complicated activities, leading position, etc.)
- Topic 3: Age
- Topic 4: Economy
- Topic 5: Region

Task (in peers)

Project on the Gender Pay Gap - Aspect: Age

Work in teams of two!

You are now to carry out a project work on the "Gender Pay Gap" with your knowledge gained in the seminar. In doing so, you should independently explore the data set for the 2006 Income Structure Survey and develop the causes for the gender pay gap on the basis of the available data.

You have learned that the differences in income between male and female workers, which are published in the media, must to be interpreted with caution because of the different aspects that determine the difference.

TASK

In this article (see link below), the focus is on the aspect "age", which has an influence on the merit difference. Under this perspective, examine the present data set and work out the extent to which merit differences are caused by the aspect mentioned above. In addition, examine other factors that affect merit differences in your aspect.

Source/Link: <http://www.bild.de/ratgeber/job-karriere/gehalt/wie-alter-und-geschlecht-ihr-gehalt-bestimmen-44537794.bild.html>

Write a short article and create a PowerPoint presentation that you will resent to your fellow students.

What our students worked on in sessions 10-12

The example of Harry and Steven

Gender Pay Gap project: Explorations with Fathom

Example: Presentation of Steven & Harry

Investigationprocess

Kollektion 1

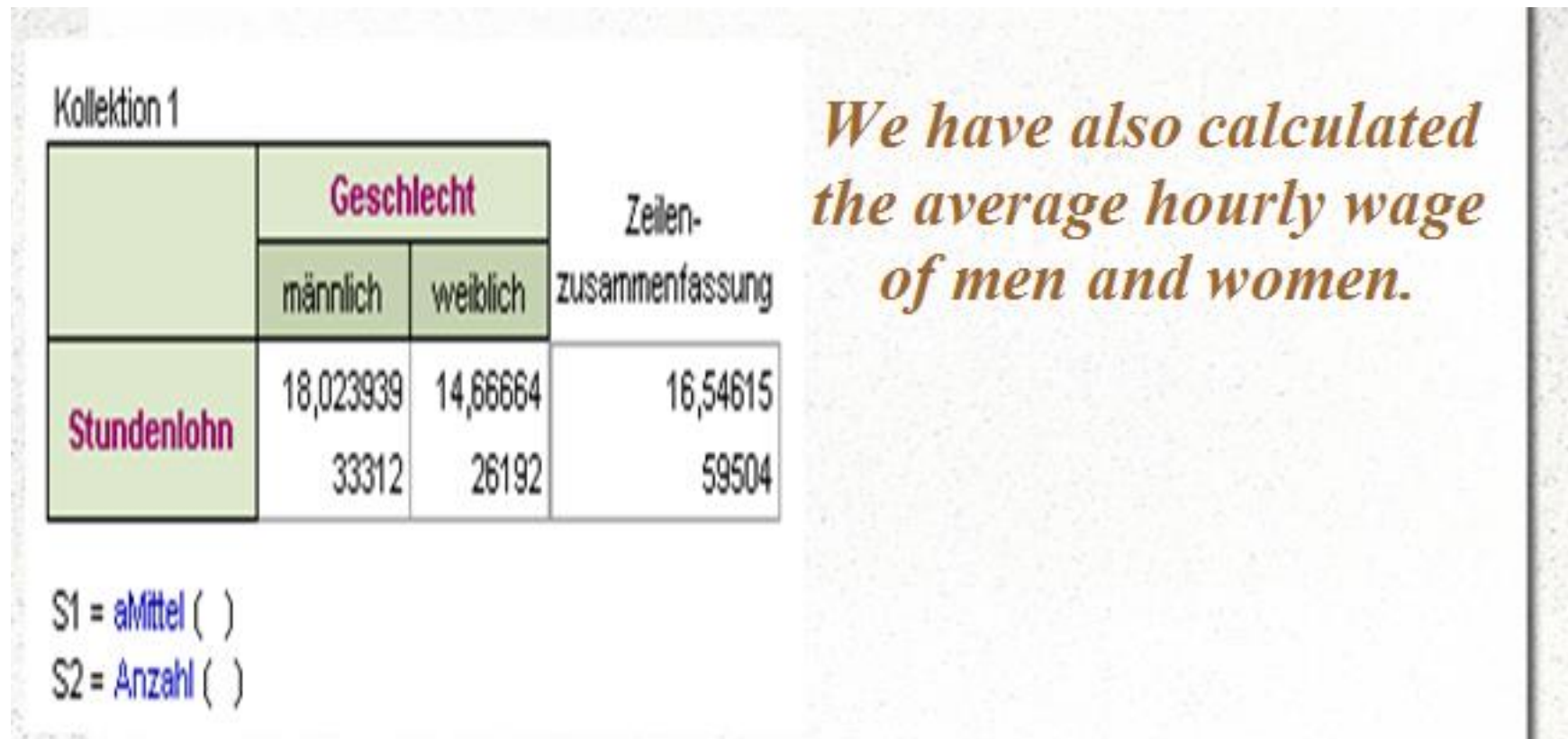
Geschlecht	männlich	33312
	weiblich	26192
Spaltenzusammenfassung		59504

S1 = Anzahl ()

In the first step, we examined the data set and worked out an absolute frequencies of men and women

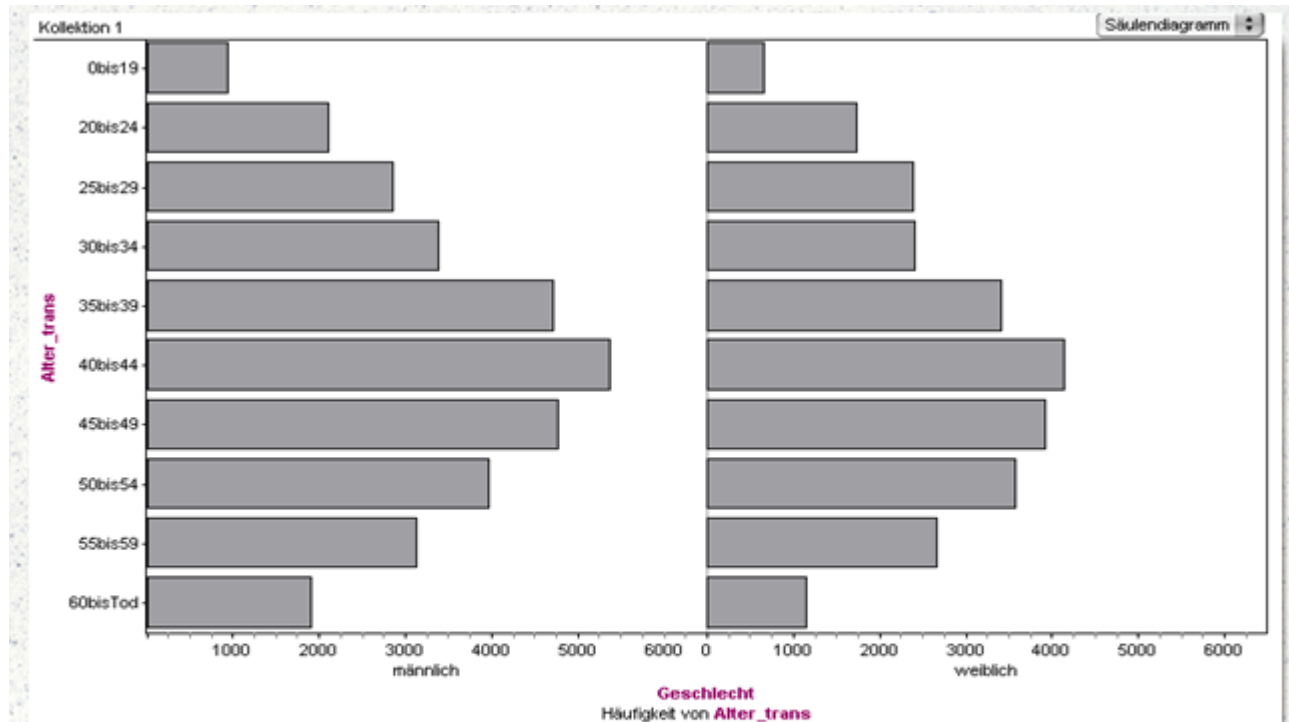
Gender Pay Gap project: Explorations with Fathom

Example: Presentation of Steven & Harry



Gender Pay Gap project: Explorations with Fathom

Example: Presentation of Steven & Harry



In order to further approach our question, we have classified the age characteristic. We were able to divide the respondents not only into male and female, but also in age groups

Gender Pay Gap project: Explorations with Fathom

Example: Presentation of Steven & Harry

Kollektion 1

		Stundenlohn
Alter_trans	0bis19	0,81318349
	20bis24	0,59370208
	25bis29	1,3882602
	30bis34	1,8972655
	35bis39	3,4162363
	40bis44	4,3117345
	45bis49	4,2073244
	50bis54	4,2874764
	55bis59	4,2865779
	60bisTod	4,6556904
Spaltenzusammenfassung		3,3572994

Finally, we calculated the difference between the average hourly wages, grouped by gender and age group.

$S1 = \text{aMittel} (? ; (\text{Geschlecht} = \text{"männlich"})) - \text{aMittel} (? ; \text{Geschlecht} = \text{"weiblich"})$

Example: Presentation of Steven & Harry

Results

As our last table clearly shows, the difference between the average hourly wages and the rising age class increases considerably (age class "0-19" difference € 0.81, age class "60 death" difference € 4.66)

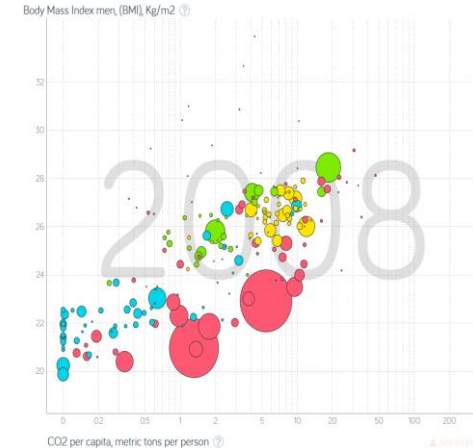
A sharp increase in the difference between age classes "30-34" and "35-39" can be seen particularly clearly. (From 1,90 € to 3,42 €)

Some insights of the exploration of Gender Pay Gap data:

- Women are missing in certain professions, sectors and on the upper end of the career ladder
- Women interrupt their careers and reduce their working time for family reasons more frequently and for longer periods than men.
- Individual and collective pay negotiations have not yet succeeded in effectively overcoming the traditionally low evaluation of female-dominated professions.

- Session 14: Working on small data projects and preparing a presentation
- Session 15: Presenting findings
- **Work & present in pairs of two**
- **4 different tasks → we will show two exemplarily**

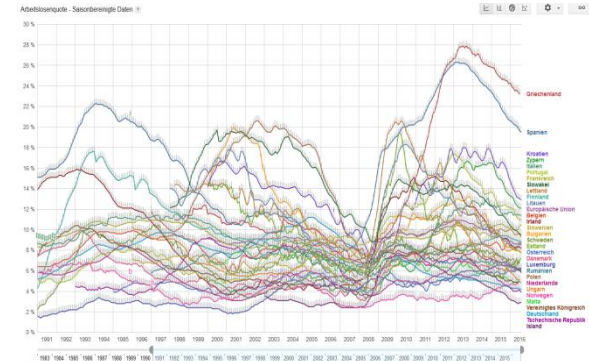
Gapminder World (task 2 of PCS booklet)



Questions:

- **Q1:** What is the relationship between CO2 emissions and the body mass index for men in China, Germany and the USA?
- **Q2:** Think of a further question with regard to other variables.
- **Q3:** What can you conclude?

Unemployment in the EU



Questions:

- **Q1:** What trends can you see in the quote of unemployment in Germany from 1991 to 2015? Compare this with the trend of the EU and another country of the EU, chosen on your own. Inform yourself about the definition of unemployment in the country.
- **Q2:** Think of a further question with regard to other variables (e.g. Age, Gender).
- **Q3:** What do you see? What could be causes for this?

Overall evaluation

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Evaluation forms for sessions and tasks

1. On a scale from 1 (does not apply at all) to 7 (fully applies), rate the following statement:
"I have understood today's task XY very well."



1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐
(does not apply at all) (fully applies)

Please explain your rating:

2. ... "I liked the contents of today's session/task very much."
3. ... "The contents of today's session/task have a large didactical potential for classrooms use."

(Handout)



Evaluation forms for sessions and tasks

Regarding the session's topic/the session's task:

Q1 aims at cognitive aspects (understanding)

Q2 aims at dispositions (like)

Q3 aims at pedagogical aspects (pedagogical)

Sessions

No	Topic	Understanding Mean	Like Mean	Pedagogical Mean
1	Introduction I	5.1	4.7	4.1
2	Introduction II	5.8	4.9	4.1
3	Exploring real data	6.1	4.9	4.6
10-12	Gender Pay Gap Reading & Working	5.7	5.2	4.3
13	Gender Pay Gap Presentation	6	5.7	Not asked
14	PCS tasks Working	5.6	5.0	4.4

Conclusion & Further plans

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Conclusion

- Our participants worked statistically on many civic contexts, which is less common in traditional statistics courses.
- Our participants were very engaged in the project work on the gender pay gap.
- The evaluation also shows that our participants liked the exploration of German Income Structure data and the presentation of their findings via PowerPoint.

- Further plans: In the next winter term 17/18, we plan to teach a redesigned course.
 - keep the general structure of the course
 - support our students in a more concrete way, especially when designing the students' sessions
 - implement more project sessions (like the project on the Gender Pay Gap), since our participants have worked on these activities very engaged and they liked them very much.
- Further research
 - Design and develop further projects for secondary preservice teacher education like the gender pay gap project in the ProCivicStat project
 - Collaboration with two school teachers to adapt and realize elements of this course for mathematics classroom at secondary school (ongoing since June 2017)

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Thank you for your attention

תודה על תשומת הלב שלך

Danke für ihre Aufmerksamkeit

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Obrigado pela sua atenção

Köszönöm a figyelmet