



# Statistical Practices: What do statisticians do?

**Layla Guyot & Alex White**  
**Texas State University**

# Importance of statistics and statisticians

- Wide range of applications for statistics (from Actuarial science to Zoology) and the era of Big Data
- Employment for statisticians expected to grow by 34% between 2016 and 2026 compared to a 7% growth rate for all occupations:

## Employment projections data for mathematicians and statisticians, 2016-26

Occupational Title	SOC Code	Employment, 2016	Projected Employment, 2026	Change, 2016-26	
				Percent	Numeric
Mathematicians and statisticians	—	40,300	53,700	33	13,500
Mathematicians	15-2021	3,100	4,000	30	900
Statisticians	15-2041	37,200	49,800	34	12,600

SOURCE: U.S. Bureau of Labor Statistics, Employment Projections program

# A need for statisticians



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“More Students Earning Statistics Degrees, But Not Enough To Meet Surging Demand for Statisticians”  
(American Statistical Association, 2015)

# A need for statisticians



“Most employers are looking for experienced statisticians when they are hiring”  
(Occupation Outlook, 2018)

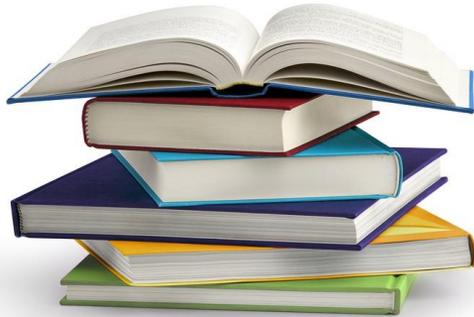
# A need for statisticians



“Needed: statisticians – not nerds –  
with workplace knowledge”  
(Mail & Guardian, 2017)

# Identifying a challenge

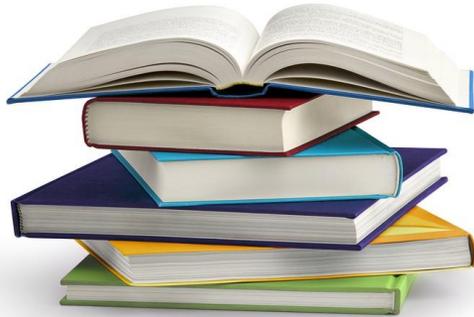
## Education



Students focus on statistical  
theory and concepts  
(Kenett & Thyregod, 2006)

# Identifying a challenge

## Education



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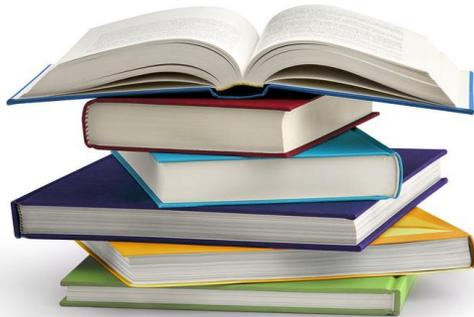
## Profession



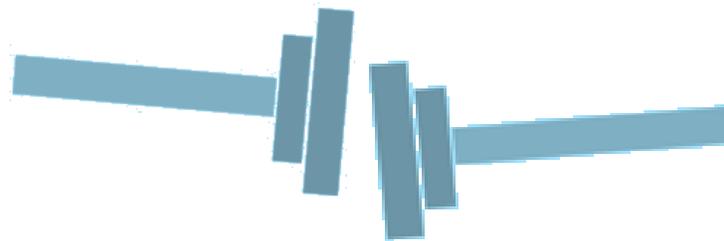
Statisticians perform statistics in a specific context  
(Pfannkuch & Wild, 2000)

# Identifying a challenge

## Education



Students focus on statistical theory and concepts  
(Kenett & Thyregod, 2006)



There is a **misalignment** for statistical practices  
(Van der Berg, 2017)

## Profession



Statisticians perform statistics in a specific context  
(Pfannkuch & Wild, 2000)

# Identifying a challenge

Van der Berg (2017) surveyed 95 intern statisticians:

- 71% agreed that they **did** acquire the appropriate **statistical knowledge** needed at the workplace
- 72% indicated that they **did not** acquire the appropriate **statistical skills** needed at the workplace

# Identifying a challenge

Respondents could list skills required at the workplace and indicate if it was taught or not:

- 21 out of a total of 28 skills were mentioned as **not being taught**
- Most cited skills were: data collection, questionnaire design, communication, writing skills, and using statistical software.

# Identifying a solution

## **a challenge**

There is a misalignment between the practices acquired through education and the practices required for the profession.

# Identifying a solution

<b>a challenge</b>	There is a misalignment between the practices acquired through education and the practices required for the profession.
<b>a possible explanation</b>	Statisticians develop practices that grow out of experience during their transition to the profession.

# Identifying a solution

<b>a challenge</b>	There is a misalignment between the practices acquired through education and the practices required for the profession.
<b>a possible explanation</b>	Statisticians develop practices that grow out of experience during their transition to the profession.
<b>a possible solution</b>	<ol style="list-style-type: none"><li>1) Identify practices developed by statisticians</li><li>2) Investigate how to include these practices in education</li></ol>

# Purpose of the study

<b>a challenge</b>	There is a misalignment between the practices acquired through education and the practices required for the profession.
<b>a possible explanation</b>	Statisticians develop practices that grow out of experience during their transition to the profession.
<b>a possible solution</b>	<ol style="list-style-type: none"><li>1) Identify practices developed by statisticians</li><li>2) Investigate how to include these practices in education</li></ol>

# Identifying statistical practices

- from the perspective of mentors at the workplace: Holmes (1997), Ritter, Starbuck, and Hogg (2001), Van der Berg (2017).
- from the perspective of statisticians: Van der Berg (2017), Pfannkuch and Wild (2000), Harraway & Barker (2005), Kent et al. (2005), Bakker et al. (2008).
- from the perspective of mentors in education: Anderson and Loynes (1987), Cameron (2006).

# Identifying statistical practices



# Participation to the study

We will now engage in a task that intends to explore your perspective on the profession of statistician.

**<http://statistician.intelledge.com/>**

Your engagement in the task is part of the workshop session, by answering the questions you are giving permission to use the results for research purposes. You can also complete a survey to share your experience or share your contact information to participate in an interview.

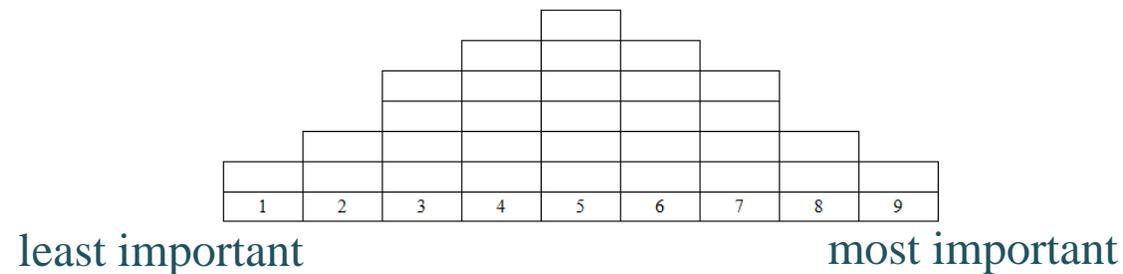
This study has been approved by the Internal Review Board (Approved IRB #6144).

# Task

<http://statistician.intelledge.com/>

From your perspective, what important practices are statisticians performing at the workplace?

Sort and arrange 24 statistical practices in order of importance, from the least important (1) to the most important (9), into the following shape:



You can **add up to 6 practices** that were not mentioned in the given list. If you have **no practice** to add, **leave column 5 blank** considered neutral.

# Discussion

Any practice that was especially challenging to order?

Compare practices on the **left and right tails** of the distributions with your neighbors.

- Comment on the differences/similarities
- How do you promote these practices in your courses?
- When do statisticians develop these practices?

Compare **additional practices** with your neighbors.

- Have you reported different additional practices?
- Why would these practices be different or similar?

# Preliminary results: Participants



	COTS April 2018	JDS June 2018	ICOTS July 2018	CSP February 2019	Total
Statistician	6	6	1	21	34
Statistician - Professor	3	2	7	2	14
Professor	9	3	0	3	15
Graduate student	2	7	0	9	18
Undergraduate student	7	0	0	4	11
<b>Total</b>	<b>27</b>	<b>18</b>	<b>8</b>	<b>39</b>	<b>92</b>

+ 5 missing

# Preliminary results: Participants

A diversity of degrees (highest degree obtained or currently pursued) in a variety of disciplines:

	Bachelor	Masters	PhD	Total
Statistics – Data Science – Biostatistics ...	0	23	21	44
Mathematics	6	0	5	11
Others: Accounting, Engineering, ...	2	3	5	10
Missing description	6	1	9	16
<b>Total</b>	<b>14</b>	<b>27</b>	<b>40</b>	<b>81</b>

# Preliminary results: Task

- Collected 63 sorting tasks
- Analysis of sorting task (Q-methodology)
  - using data reduction to identify patterns of thought
  - applying PCA on tasks (participants are correlated)
  - identifying 3 groups of participants
  - identifying 3 perspectives

# Task: Categories of practices

Process of data analysis			Traits	
Design	Focus on data	Techniques	Interpersonal skills	Personal skills
<ul style="list-style-type: none"> <li>- Using knowledge of the context</li> <li>- Translating a real problem into a statistical form</li> <li>- Designing studies</li> <li>- Preparing sampling frames</li> </ul>	<ul style="list-style-type: none"> <li>- Collecting data</li> <li>- Creating / Maintaining databases</li> <li>- Cleaning data</li> <li>- Using statistical software</li> <li>- Producing visual representations</li> <li>- Interpreting data</li> </ul>	<ul style="list-style-type: none"> <li>- Researching appropriate statistical methods</li> <li>- Developing new statistical methods</li> <li>- Applying statistical methods</li> <li>- Using advanced mathematics</li> </ul>	<ul style="list-style-type: none"> <li>- Participating in teams / Collaborating</li> <li>- Communicating in writing</li> <li>- Communicating orally</li> <li>- Consulting with a client</li> <li>- Communicating interpretations of statistics to non-statisticians</li> </ul>	<ul style="list-style-type: none"> <li>- Working independently</li> <li>- Being curious / willing to learn</li> <li>- Being skeptical / critical</li> <li>- Meeting deadlines</li> <li>- Considering ethical issues</li> </ul>

# Task: Perspective 1

					Meeting deadlines			
		Considering ethical issues			Participating in teams / Collaborating	Being curious / willing to learn		
		Working independently	Being skeptical / critical		Communicating orally	Communicating in writing		
	Creating / Maintaining databases	Preparing sampling frames	Using knowledge of the context	Designing studies	Using statistical software	Translating a real problem into a statistical form	Consulting with a client	
Developing new statistical methods	Using advanced mathematics	Collecting data	Researching appropriate statistical methods	Cleaning data	Producing visual representations	Interpreting data	Applying statistical methods	Communicating interpretations of statistics to non-statisticians
1	2	3	4	5	6	7	8	9

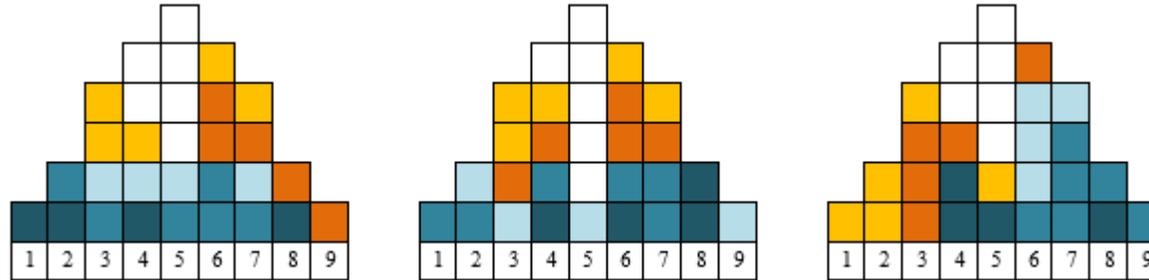
# Task: Perspective 2

					Being skeptical / critical			
		Meeting deadlines	Considering ethical issues		Participating in teams / Collaborating	Being curious / willing to learn		
		Working independently	Communicating in writing		Communicating orally	Communicating interpretations of statistics to non-statisticians		
	Preparing sampling frames	Consulting with a client	Cleaning data		Producing visual representations	Using statistical software	Researching appropriate statistical methods	
Creating / Maintaining databases	Collecting data	Using knowledge of the context	Using advanced mathematics	Designing studies	Developing new statistical methods	Interpreting data	Applying statistical methods	Translating a real problem into a statistical form
1	2	3	4	5	6	7	8	9

# Task: Perspective 3

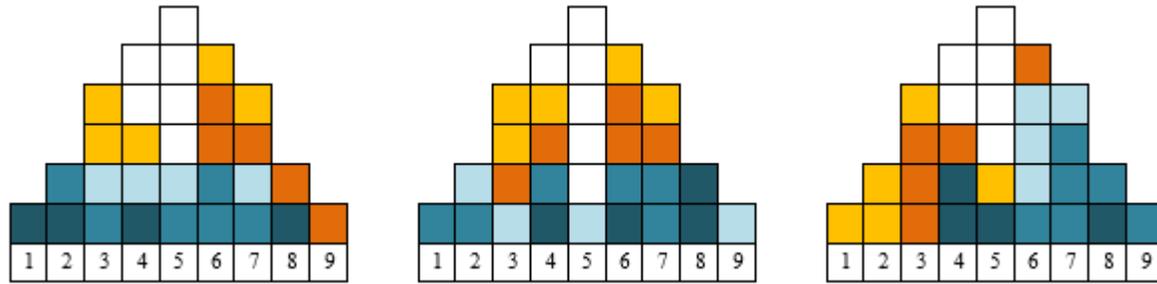
					Consulting with a client			
		Participating in teams / Collaborating			Designing studies	Translating a real problem into a statistical form		
		Working independently	Communicating interpretations of statistics to non-statisticians		Preparing sampling frames	Collecting data		
	Considering ethical issues	Communicating orally	Developing new statistical methods	Meeting deadlines	Using knowledge of the context	Producing visual representations	Cleaning data	
Being curious / willing to learn	Being skeptical / critical	Communicating in writing	Using advanced mathematics	Researching appropriate statistical methods	Using statistical software	Interpreting data	Applying statistical methods	Creating / Maintaining databases
1	2	3	4	5	6	7	8	9

# Task: Perspectives



	Perspective 1		Perspective 2		Perspective 3	
% explained variance	20.61		14.01		8.64	
Number of loading sorts	24		20		7	
	+	-	+	-	+	-
Statistician	14		4	1	1	1
Statistician – Professor	1		4			2
Professor	3		2			
Graduate student	4		7		1	
Undergraduate student	2		2		2	

# Task: Adding results from today!



	Perspective 1		Perspective 2		Perspective 3	
	+	-	+	-	+	-
Preliminary results	24	0	19	1	4	3
Session 1	9	0	6	0	0	1
Session 2	12	0	0	0	0	0

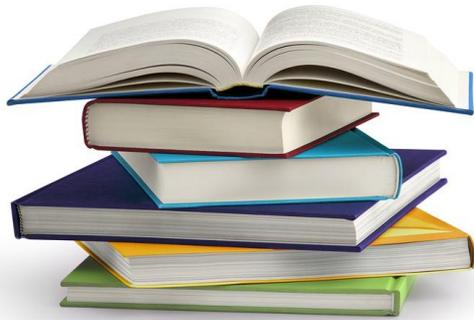
# Task: Additional Practices

Practices	Occurrences
Training constantly / Learning / Reading	10
Mentoring / Teaching / Providing feedback	10
Managing projects / budget / people	9
Developing computer skills	3
Communicating with clients / contractors / other departments	3
Complying with Data Security / Privacy regulations / Ethics	2

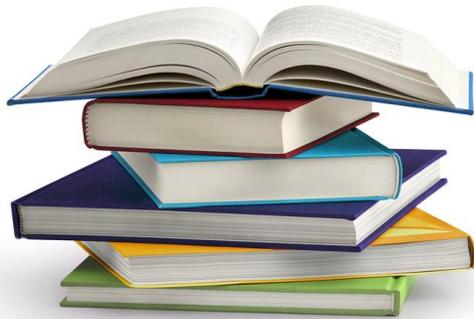
# Preliminary results: Survey

- Collected 81 questionnaires
  - open-ended questions
  - educational background, professional experience, and experience of the transition to the profession
- Analysis of survey
  - qualitative analysis
  - create categories / themes

# Survey: Top 5 practices

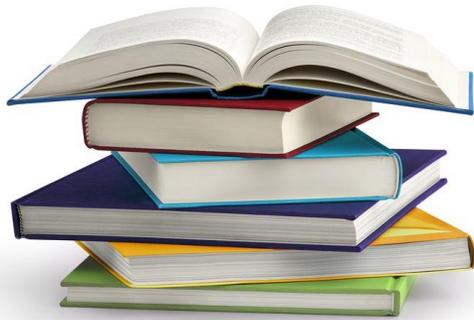


# Survey: Top 5 practices developed in education



Practices	Occurrences
General statistical methods	29
Programming	18
Designing studies	11
Presentation	8
Work habits (interpersonal skills)	7

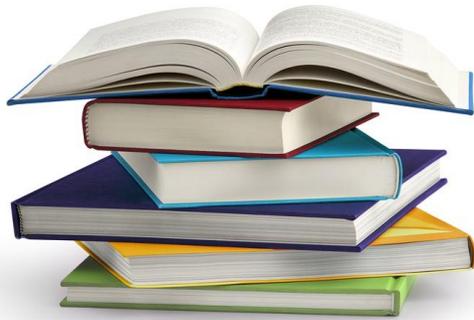
# Survey: Top 5 practices developed for the profession



Practices	Occurrences
General statistical methods	29
Programming	18
Designing studies	11
Presentation	8
Work habits (interpersonal skills)	7

Practices	Occurrences
Communication	19
Specific statistical methods	17
Programming	11
Data management	8
Designing studies	6

# Survey: Top 5 recommendations for education



Practices	Occurrences
Data management / Real data	12
Projects / Consulting courses	11
Programming	10
Use real scenario, case studies, applications	10
Theory tied to practice	7

# Future Research

Next:



- Interviews will be conducted with participants willing to share their experience of the transition to the profession and
- how they learned to develop statistical practices at the workplace
  - or help young statisticians learn to develop these practices.

# Wrapping up

Make sure to:

- (1) submit the task
- (2) start the survey or save the link for later
- (3) share your contact for an interview.

The survey, and ultimately the interview, will enable a rich and detailed description of the experiences of statisticians.

# References

- ❑ American Statistical Association. (2015, October 1). More Students Earning Statistics Degrees, But Not Enough To Meet Surging Demand for Statisticians.
- ❑ Brown, S. R. (1980). *Political subjectivity: Applications of Q methodology in political science*. New Haven, CT: Yale University Press.
- ❑ Bureau of Labor Statistics, U.S. Department of Labor (2018). *Occupational Outlook Handbook*.
- ❑ Kenett, R., & Thyregod, P. (2006). Aspects of statistical consulting not taught by academia. *Statistica Neerlandica*, 60(3), 396-411.
- ❑ Ministry of Business, Innovation and Employment in New Zealand (2017). *Occupational Outlook*.
- ❑ Pfannkuch, M., & Wild, C. J. (2000). Statistical thinking and statistical practice: themes gleaned from professional statisticians. *Statistical Science*, 15(2), 132-152.
- ❑ Van der Berg, G., H. (2017). A framework to integrate the formal learning with the informal workplace learning of statisticians in a developmental state (Doctoral Dissertation).

Thank you for your participation!

Questions?

If you are interested in taking part in interviews  
or spreading the word about this research  
please contact Layla Guyot at [1\\_g244@txstate.edu](mailto:1_g244@txstate.edu)

<http://statistician.intelligentedge.com/>