Adaptive learning

- A quantitative assessment of learning impact.

Jan K. Møller
Introstat team

DTU Compute
Section for Dynamical Systems
Technical University of Denmark
jkmo@dtu.dk

DTU LearnT Conference 2021, December 2021

Overview

1. The introstat team
2. Learning resources and activities
3. Adaptive learning project
4. Student use and assessment
5. Effect measure

The introstat team

- Formed in 2014
- 4-6 teachers from two sections
- 5 courses/year (2 spring, 2 Autumn, 1 Summer)
- Share teaching and exams
- Maintain learning courses, web-page, book, exercises projects
- 3 different courses (1 Bachelor of engineering, 2 Bachelor of science)
- Total of around 1400 students/year

Learning resources and activities

- The eNote (a traditional style textbook available online)
- Podcasts (video recordings of lectures in Danish and English)
- Weekly/daily lectures
- Quiz's for each Chapter (not available for 02403)
- Weekly agendas with precise reference to sections of the book and solutions to weekly exercises
- Weekly exercises including solutions
- R-code for slides, book examples and solutions
- Access to previous exams, including argued solutions
- 1 or 2 project to be approved to go to the exam

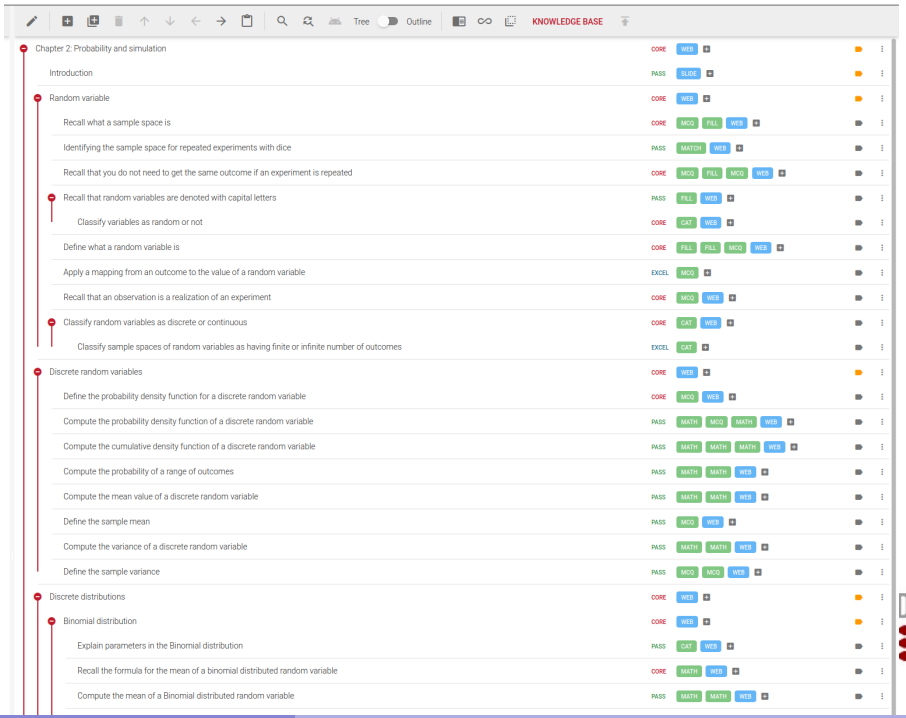
Adaptive learning project

- Start 2018, first student test in 2019.
- 6-7 TA constructing the questions and members of the team following the progress and discussion the results
- Implemented about 800 questions (probes)
- Improve probes by student feedback

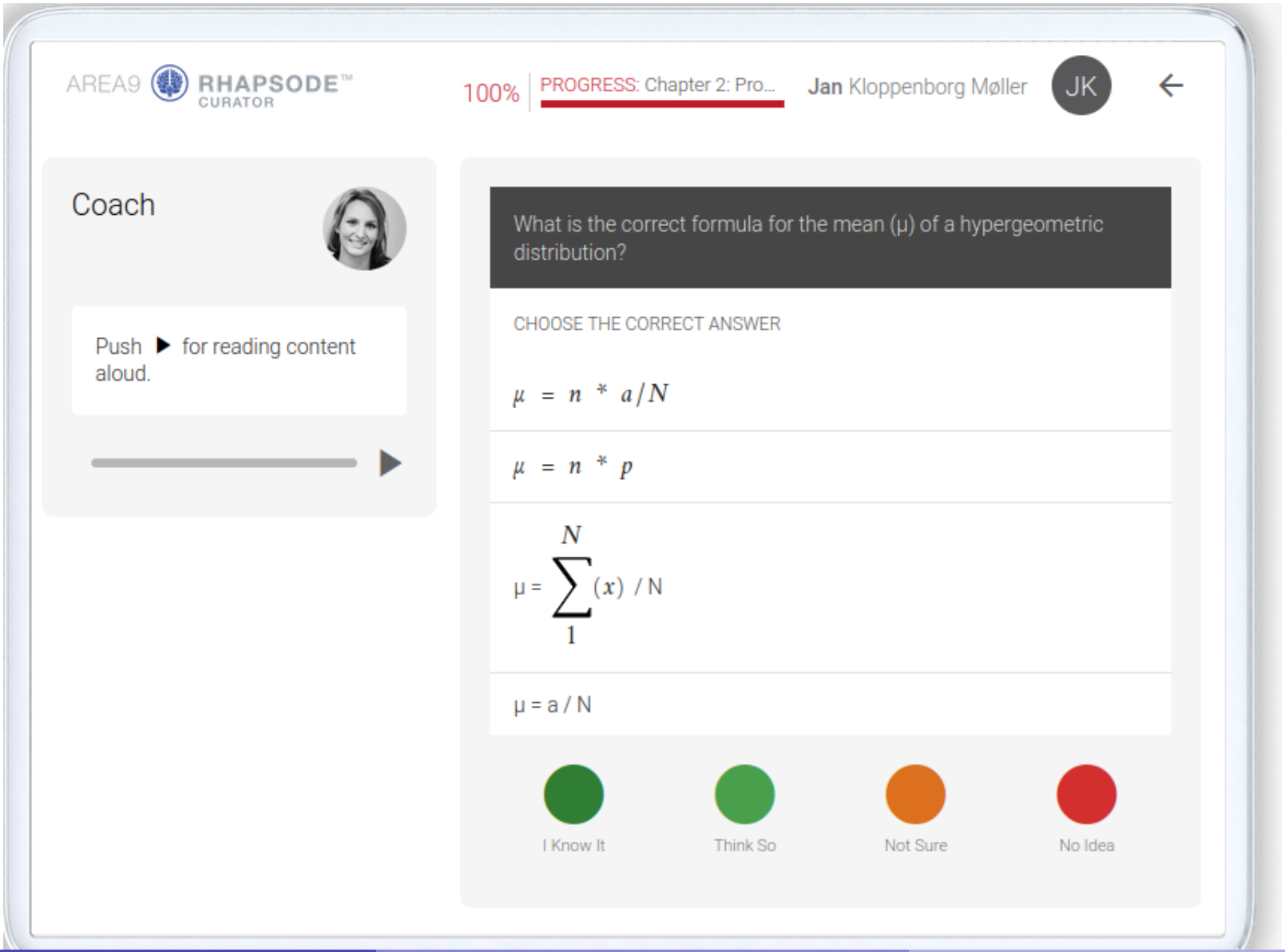
AREA9 RHAPSODE™ CURATOR

Modules

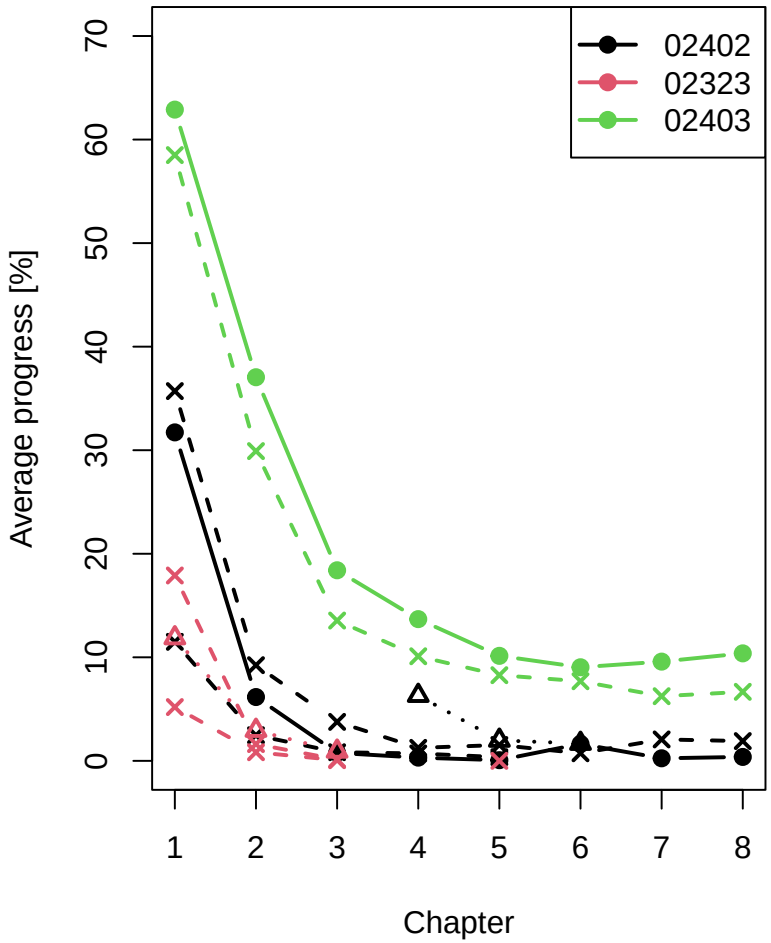
MODULE ↑	OBJECTIVES	PROBES	RESOURCES
Certification - Lasse	12	15	8
Chapter 1: Data visualization	33	45	33
Chapter 2: Functions of random variab...	24	19	0
Chapter 2: Probability and simulation	132	156	123
Chapter 3: Statistics for one and two s...	125	164	119
Chapter 4: Simulation Based Statistics	48	72	48
Chapter 5: Simple Linear regression	73	117	73
Chapter 5: Simple linear regression - ...	4	2	0



Area9: Student perspective



Student use



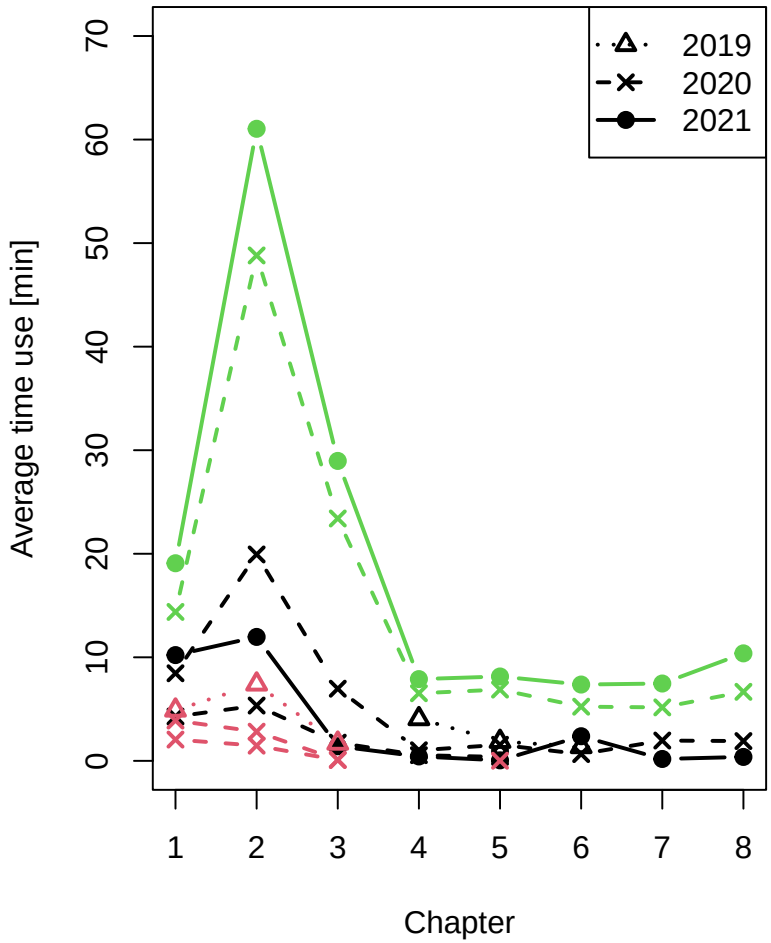
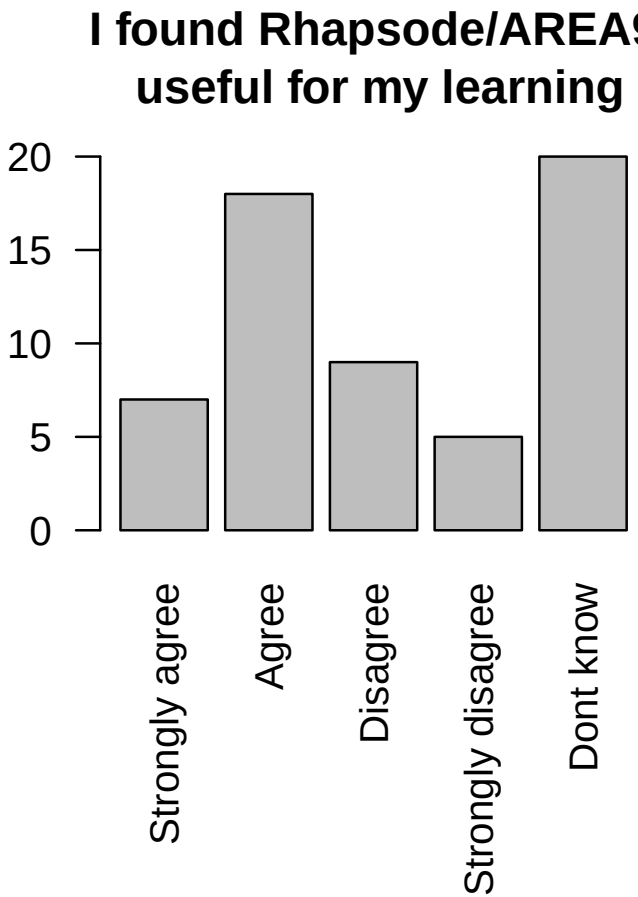


Figure: 02323: Introduction to Statistics (B. Eng.), 02402: Introduction to Statistics (B. Sci.), 02403: Introduction to Mathematical Statistics (B. Sci.)

Student easement



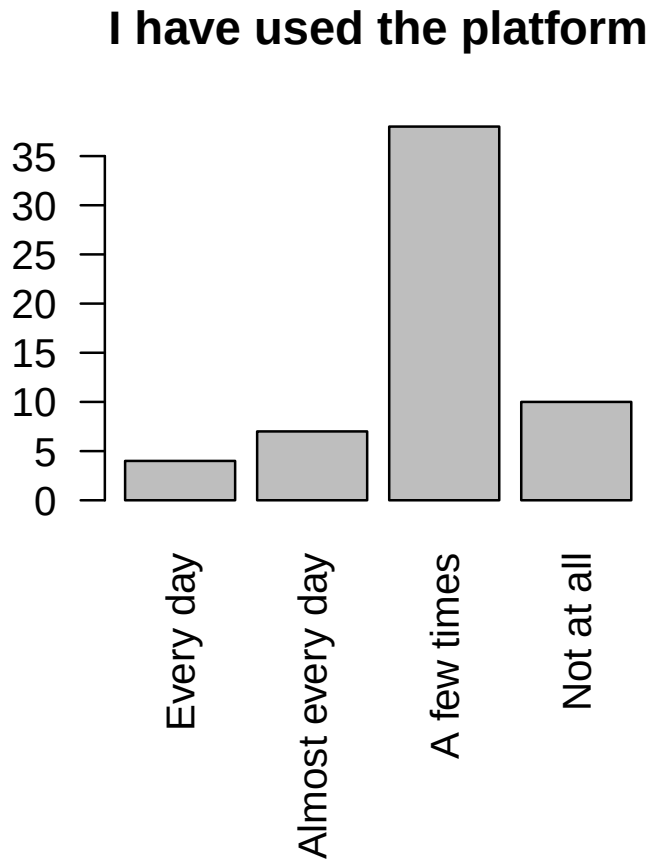


Figure: Evaluation results from 02403, the total number of students were 309.

Table: Main qualitative statements from student evaluation

Positive	Negative
Understanding	Too time-consuming
Helps remember/Repetition	Too long sessions
Good at adjusting level	Links to eNote
Result right away	Fields with free text
Interesting perspective on material	Some errors (spelling and results)
Overview and training	

Effects measure

Effects measured by exam performance

- 20 exams
- 693 questions
- 4946 students
- 137,924 answers
- App. 400 students used more 1h on Rhapsode
- Generalized Linear Mixed Effect model controlling for:
  - Study program
  - Chapter
  - Variation between student and questions

Question VII.1 (23)

Which conclusion can be drawn at significance level $\alpha = 5\%$ from this analysis (both conclusion and argument must be correct)?

1 ☐ There is no significant effect of mix, however there is a significant effect of participant, since the relevant p-values are 0.68 and 0.0083, respectively

2 ☐ There is neither a significant effect of mix nor participant, since the relevant p-values are 0.093 and 0.17, respectively

3 ☐ There is both a significant effect of mix and participant as the relevant p-values are 0.0034 and 0.014, respectively

4 ☐ There is both a significant effect of mix and participant as the relevant p-values are 0.023 and 0.57, respectively

5 ☐ There is a significant effect of mix, however, there is no significant effect of participant, since the relevant p-values are 0.0045 and 0.85, respectively

Question VII.2 (24)

How much of the total variation is explained by the model used?

1 ☐ $\frac{4+7}{28} = 0.393$

2 ☐ $\frac{7.3-1.82+77.5-11.07}{89.1-3.18} = 0.837$

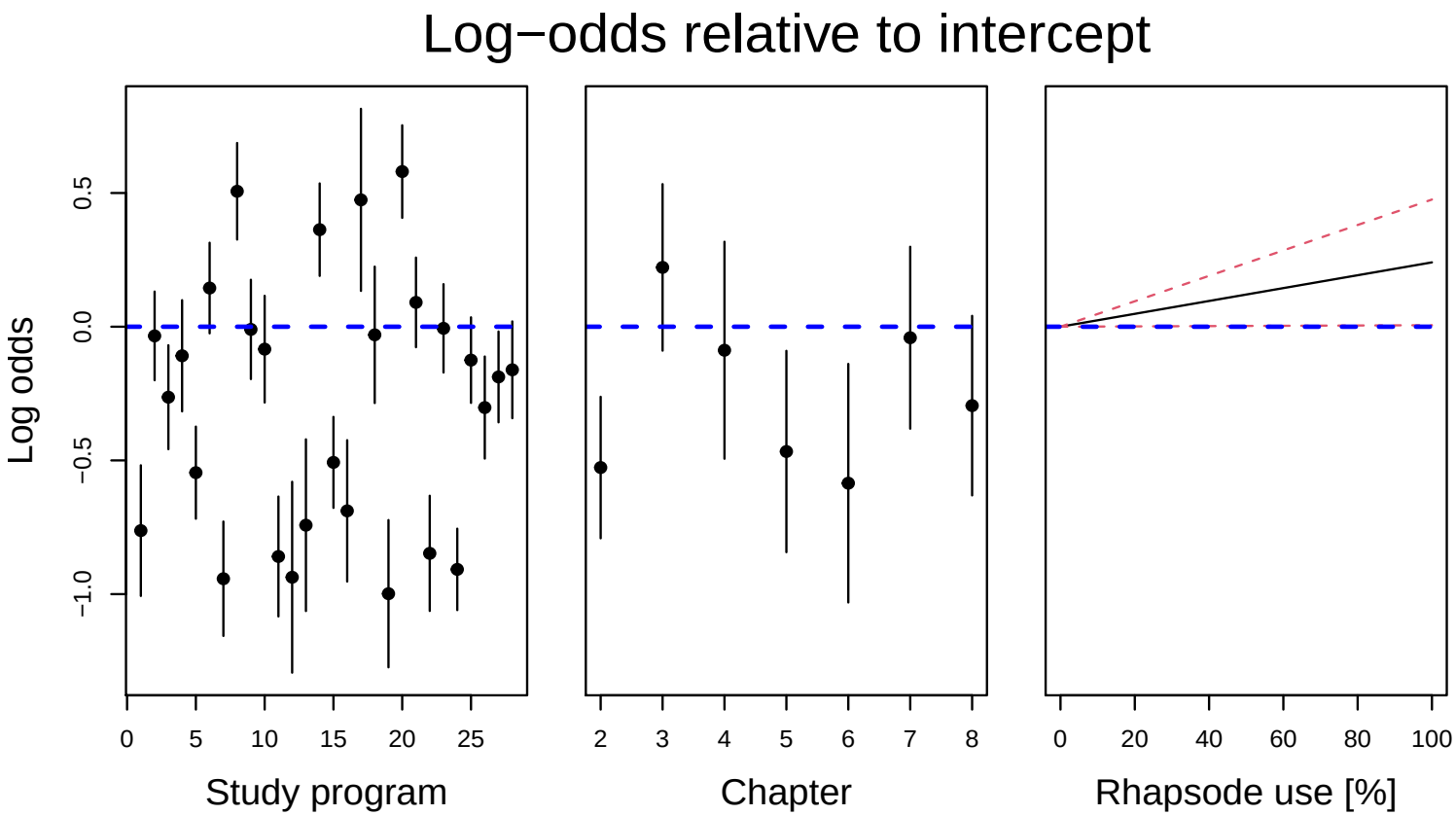
3 ☐ $\frac{7.3+77.5}{89.1} = 0.952$

4 ☐ $\frac{7.3+77.5}{7.3+77.5+89.1} = 0.488$

5 ☐ $\frac{1.82+11.07+3.18}{7.3+77.5+89.1} = 0.0924$

Continue on page 22

Effects measure – Results



$$Y_{ij} \sim Binom(p_{ij}, 1); \quad p_{ij} = \frac{e^{\eta_{ij}}}{1 + e^{\eta_{ij}}}$$

$$\eta_{ij} = \mu + \alpha(i) + \beta(j) + \gamma x_{ij} + a(i) + b(j)$$

$a(i) \sim N(0, \sigma_a^2)$ student effect

$b(j) \sim N(0, \sigma_b^2)$ effect of questions

Discussion and conclusion

- There is borderline significant effect of Area9 use
- Limitations: Limited knowledge about student background, and not randomized
- Feedback from students
  - Positive: testing, repetition, immediate feedback, new perspective
  - Negative: Time consuming, errors, some question types
- Ongoing work: Improve questions based on student feedback, monitor the effect (update effect study)

Thank you!

Questions?

[1] Jan Kloppenborg Møller, Peder Bacher, Mikkel Lindstrøm Sørensen, and Lasse Engbo Christiansen, (2020), *Adaptive learning in introstat courses at DTU*, Available on request (jkmo@dtu.dk)