

# **Statistical Literacy: Using teaching data to understand student learning**

**Joint Q-Step and British Academy Quantitative Skills Teaching and Learning  
symposium  
London, 25<sup>th</sup> June 2018**

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**<http://www.q-step.ed.ac.uk/>**

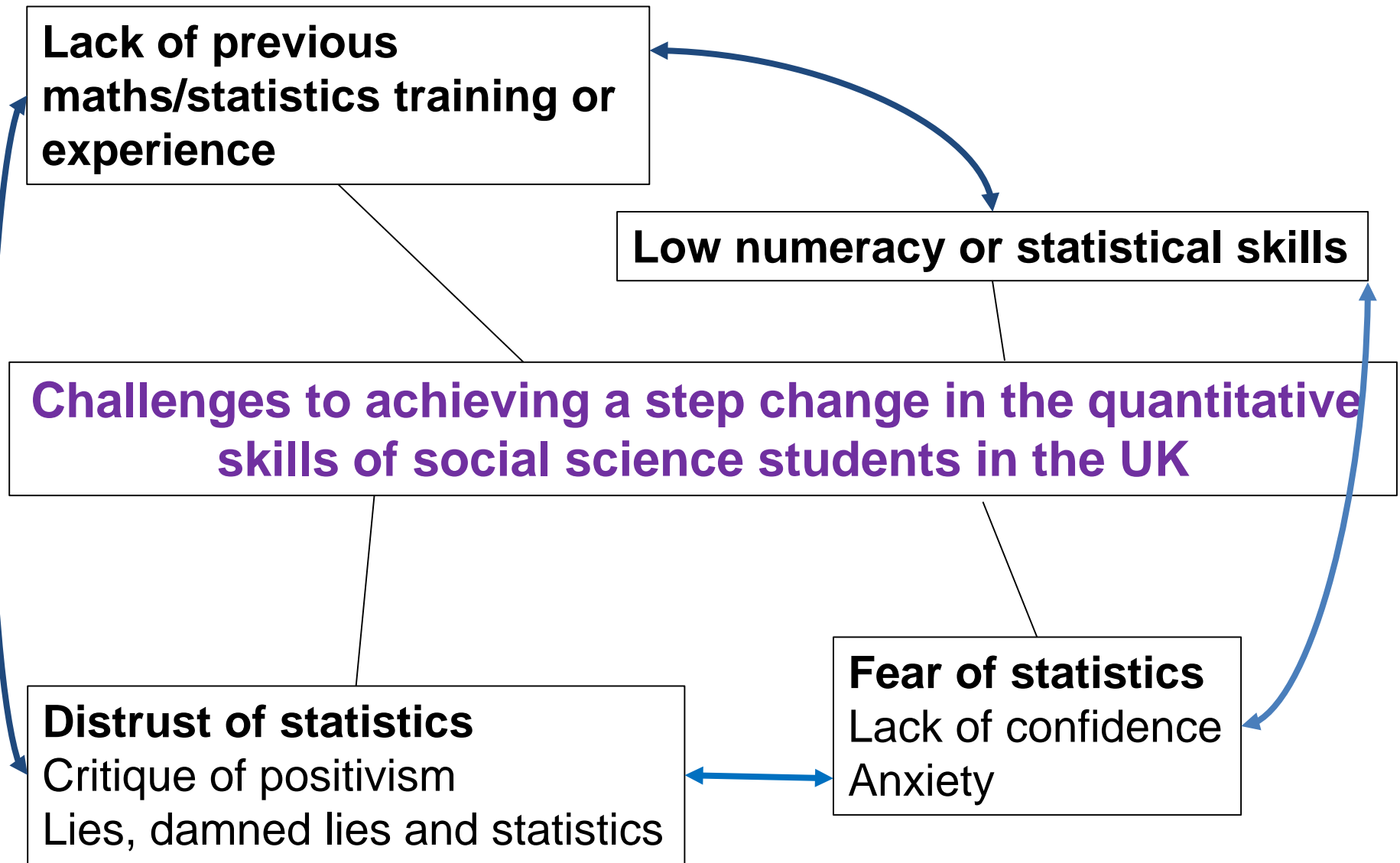
# Aims of presentation

## ***Aims***

- Exploration of the factors associated with doing well in Statistical Literacy
  - Scores on Quizzes / Take Home test
  - Course survey (longitudinal): Anxiety, mistrust of statistics, math/statistical background, study skills, .....
  - Part of an ongoing programme of research at Edinburgh Q-Step (see for example [We need to talk about Statistical Anxiety](#) (Ralston et al. 2016))

## ***Research questions***

1. Is anxiety (towards statistics or in general) associated with poorer assessment outcomes?
2. Do those with maths/statistics backgrounds outperform those without such prior training?
3. Is tutorial attendance associated with better assessment scores?



To what extent does Statistical Literacy and its delivery style overcome such barriers?

# Statistical literacy

## **Introductory statistics course that aims to equip students with skills in social statistics to critique validity of statistical claims**

- 1<sup>st</sup>/2<sup>nd</sup> year (124 students)
- Excel to analyse large-scale social surveys (E.g Health Survey for England)
- Open to students from across the university

## **Lectures (2 one hour lectures for 10 weeks)**

- Statistics theory (bivariate linear regression, Bayes theorem, stats inference)
- Linked to social issues/debate (e.g. gender pay-gap, cycling helmets)

## **Tutorials (one tutorial each week for 10 weeks)**

- Led by tutors
- Small groups (10-15 students) – 10 tutorial groups each week
- Various activities: Excel-based analysis, discussion, sampling exercises, opportunity to ask questions

# Weekly quizzes

- Multiple choice often involving statistical calculations (confidence intervals, application of binomial or Bayes theorem) and some Excel based analysis
- Average quiz score taken (weeks 1-10)

## *Example of quiz questions*

1. Fit a regression line to the data for year and rainfall, and calculate its slope. What is it?
2. Suppose that in 2000, the probability that a cyclist in the Tour de France was involved in doping was 0.8. If a random sample of three cyclists were taken, what is the probability that all three were **not** involved in doping?
3. What is the lower bound of the 95% confidence interval for the number of cigarettes smoked by adult women smokers each week in Britain

# Take Home Test

- **Part A:** use the Health Survey for England (and Excel) to consider associations and mechanisms linking obesity and health outcomes (structured questions guiding analysis)
- **Part B:** Essay-based including open questions where students reflect on use of statistics to understand social research questions:
  - *You are a researcher and have been employed by the UK Government to review the statistical evidence on the gender pay gap in the UK. Produce a short report (of up to 2 sides) on this issue using statistical evidence that you can find online and in published reports.*
  - *Discuss the challenges of using statistics to identify a causal link between the characteristics of a neighbourhood and the health outcomes of the resident population*
  - *Find any news or current affairs article published at any time after 1st January 2018 that uses quantitative evidence in a way that you find problematic.*

# Data and modelling framework

## Dependent variables

### Quiz scores

- Multiple choice
- statistical questions
- Excel-based analysis

### Take home test essay

- Essay questions
- Interpretation of statistics
- Use of statistics to comment on social issues

## Explanatory variables

### Prior experiences

- Nature of degree (Arts, Humanities, Science, Maths)
- Arithmetic/probability skills in week 1
- Self-reported maths ability
- Self-reported experience using Excel

### Study skills

- Set of questions on good study skills (self-reported)
- Tutorial attendance

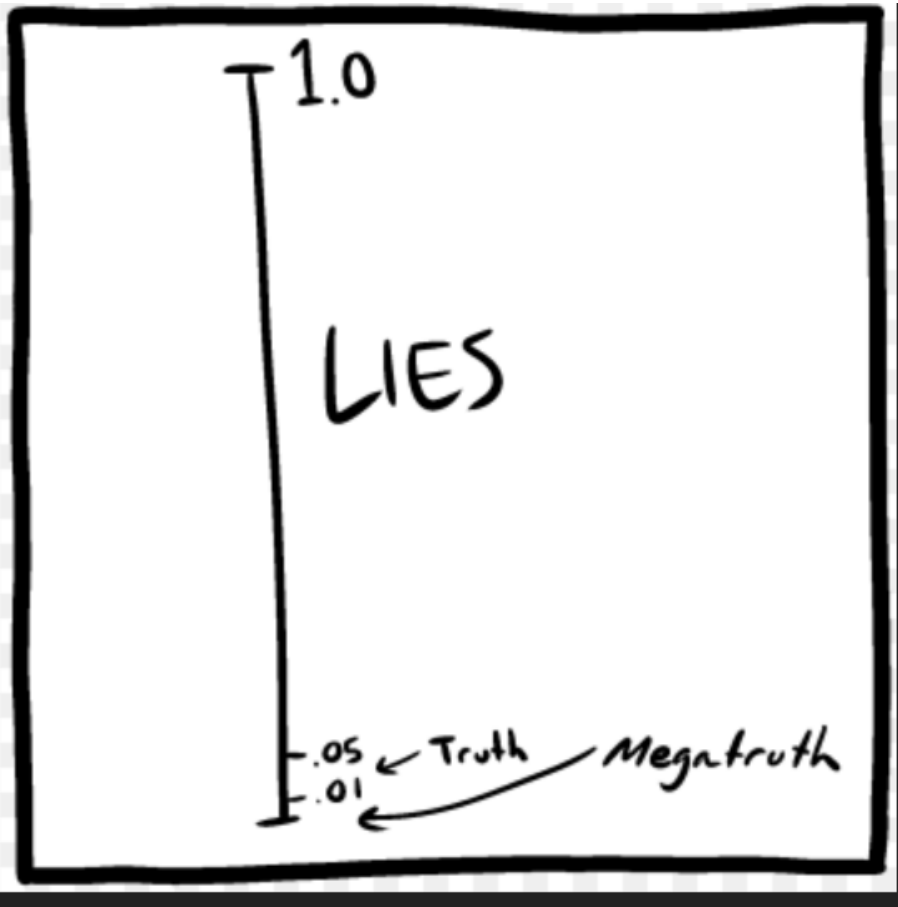
### Engagement

- Perceived course difficulty (midpoint)
- Interest in course (midpoint)
- Attitudes towards statistics at week1

### Anxiety

- General trait (sum of various forms of anxiety e.g. feeling secure, calm, able to make decisions)
- Statistical anxiety – at start, middle and end

# Challenge.....



Small sample (124)

Lack power to detect statistically significant associations in many (not all) cases

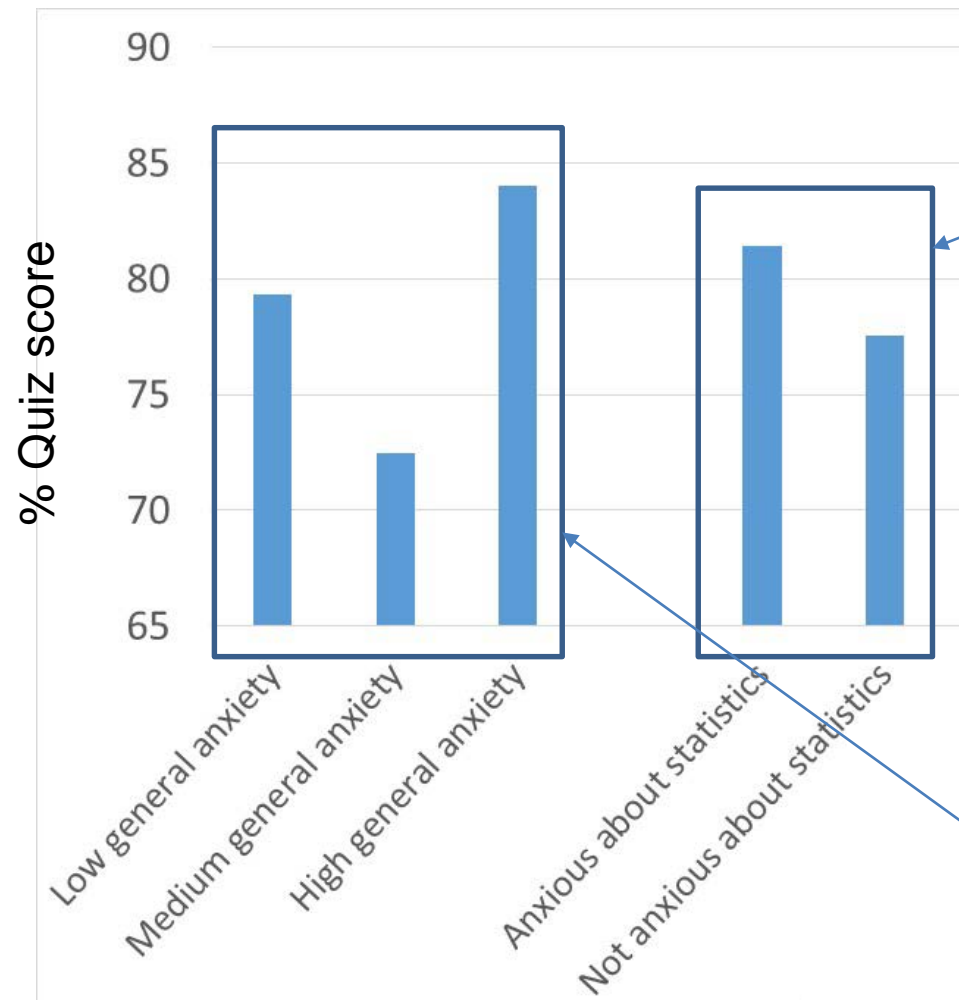
Experimental analysis to develop hypothesis for further testing

Combine quantitative analysis with qualitative feedback from students and Experiences teaching the course

Plan to combine data across years/courses



# Quiz marks: Anxiety (bivariate analysis)

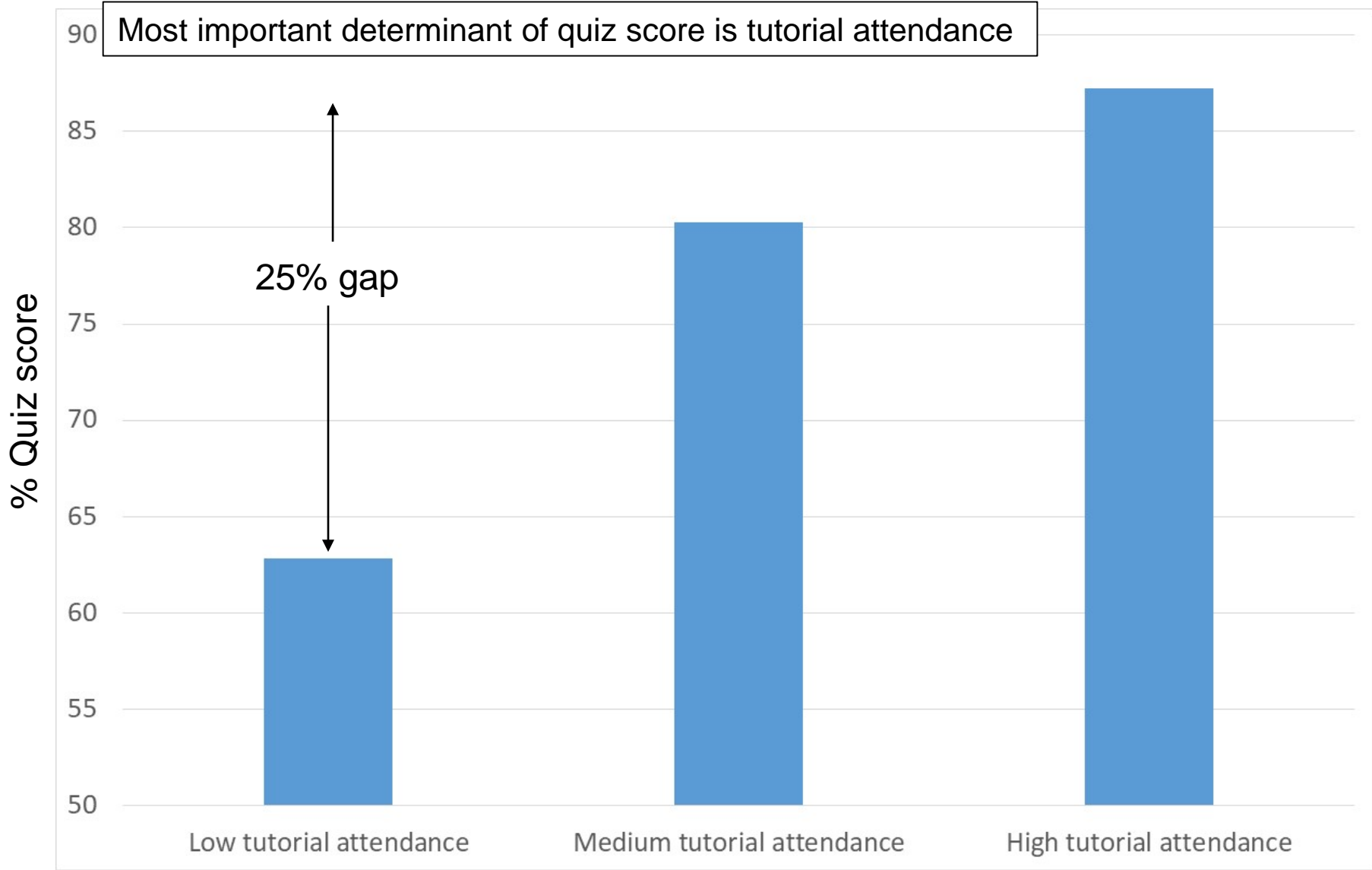


Those anxious about learning statistics at the start of the course do better on quizzes than those who are not anxious

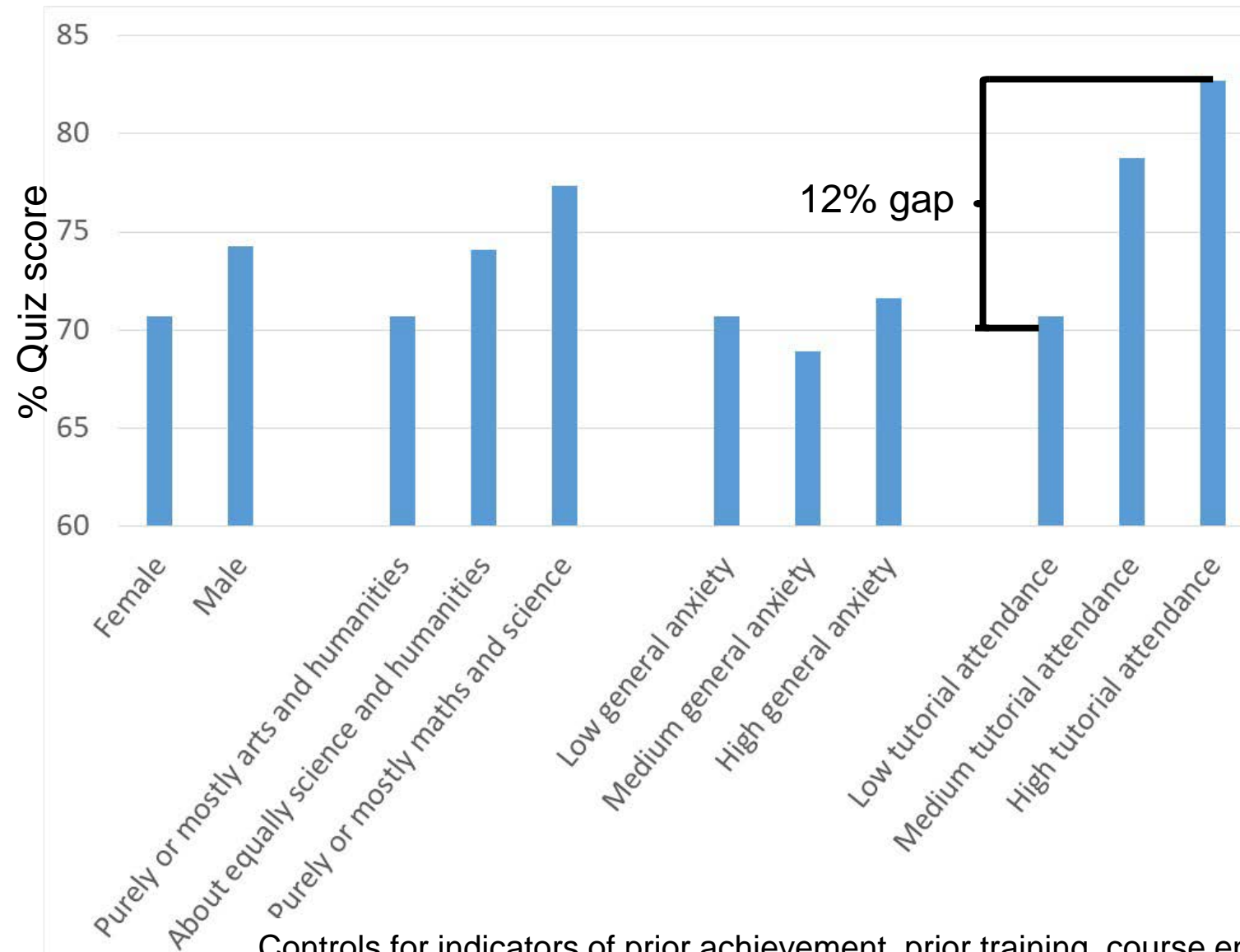
Students with highest levels of general anxiety (based on a set of self-reported questions) scored significantly higher on the quiz.

Suggestion that those with low anxiety to better than students with medium levels of anxiety

# Quiz score: tutorial attendance (bivariate analysis)



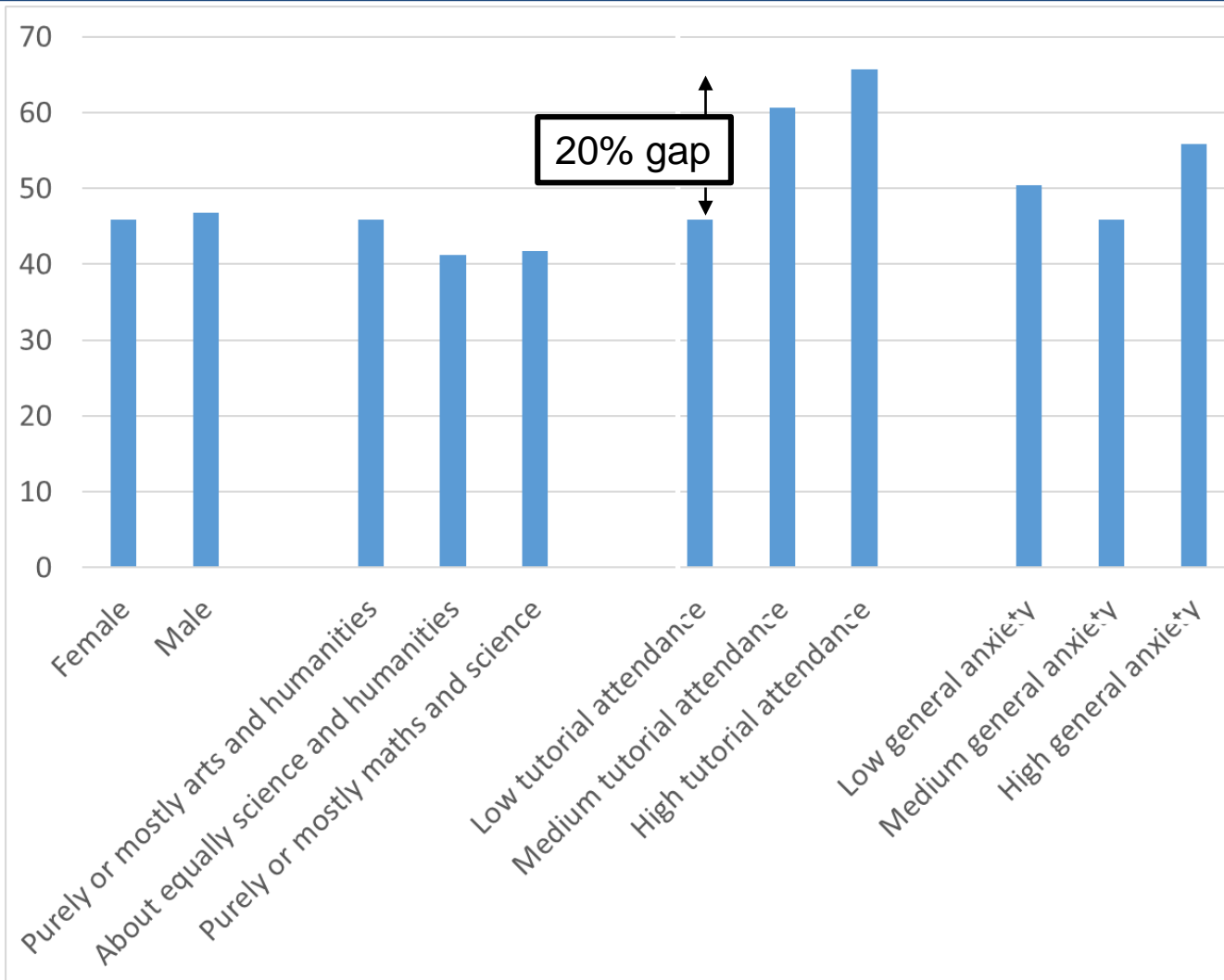
# Multivariate model of correlates of quiz performance



Attenuated coefficients reflecting correlations between explanatory variables

Directions of association remain

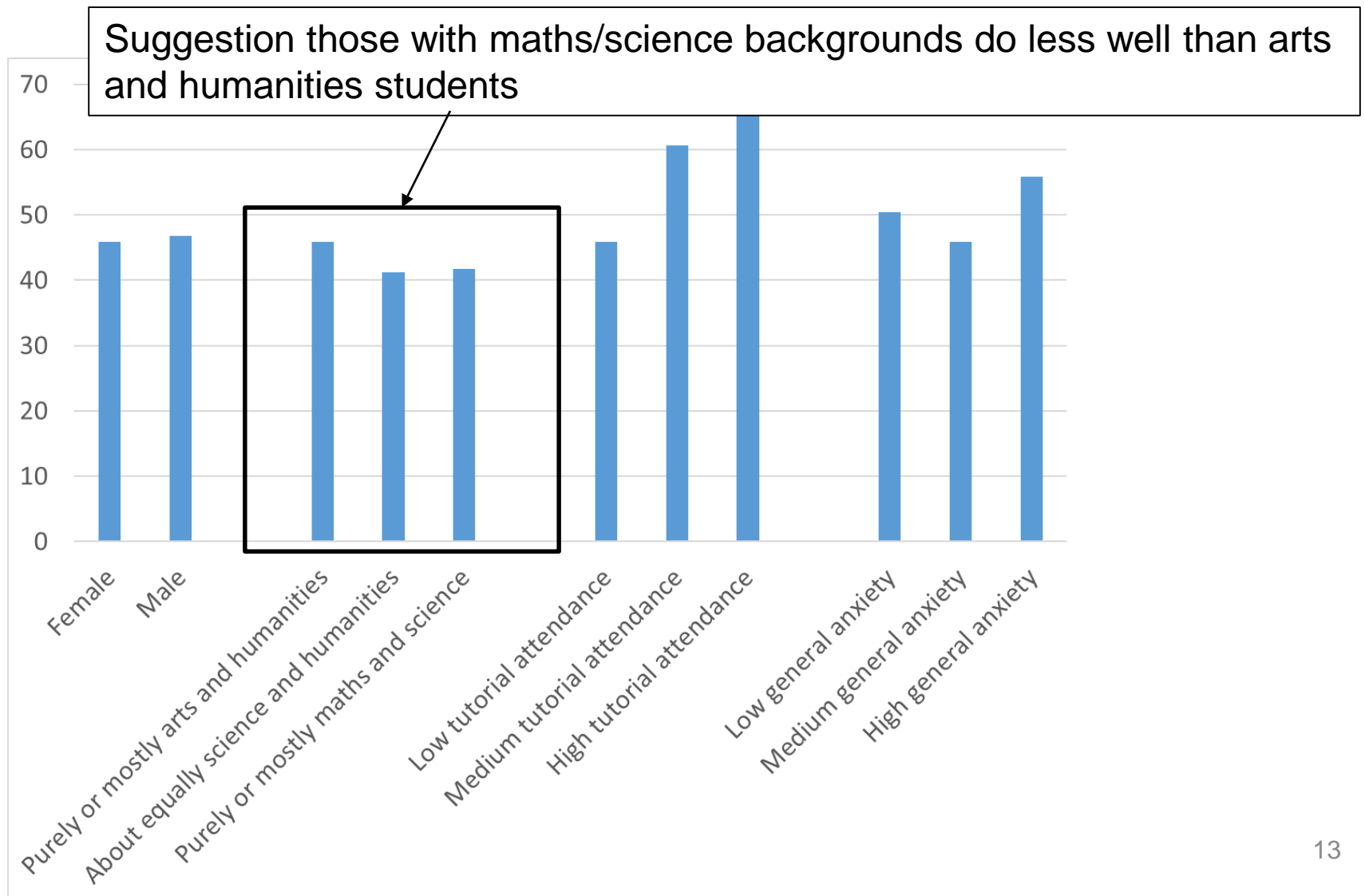
# Multivariate model of correlates of take home test performance



Similar results  
to Quiz score  
models

Highest result  
High anxiety  
High attendance

# Multivariate model of correlates of take home test performance



# RQ1: Is anxiety (towards statistics or in general) associated with poorer assessment outcomes?

- Higher levels of anxiety (towards learning about statistics or in general) associated with doing well on quizzes and the take home test
  - Anxiety not always bad (in moderation)
  - Those students who perhaps are most anxious about statistics likely don't select the course
- Macher et al. (2011, 2015) suggest that statistics anxiety can have a positive effect on performance (outside exams) possibly through learning behaviours across a course
- How does anxiety change across the course?

## RQ2: Do those with maths/statistics backgrounds outperform those without such prior training?

- Maths/statistics background associated with higher mark on quizzes but not for the take home test which has more open-ended questions that require critical analysis and interpretation of social statistics
- Courses such as Statistical literacy have the potential to benefit students in social sciences **AND** maths/science
- Nomi and Raudenbush (2016) and Gamoran (2010) suggest that weaker secondary school students do better in mixed ability groups if supplementary materials are provided for students who are struggling in class

## RQ3: Is tutorial attendance associated with better assessment scores?

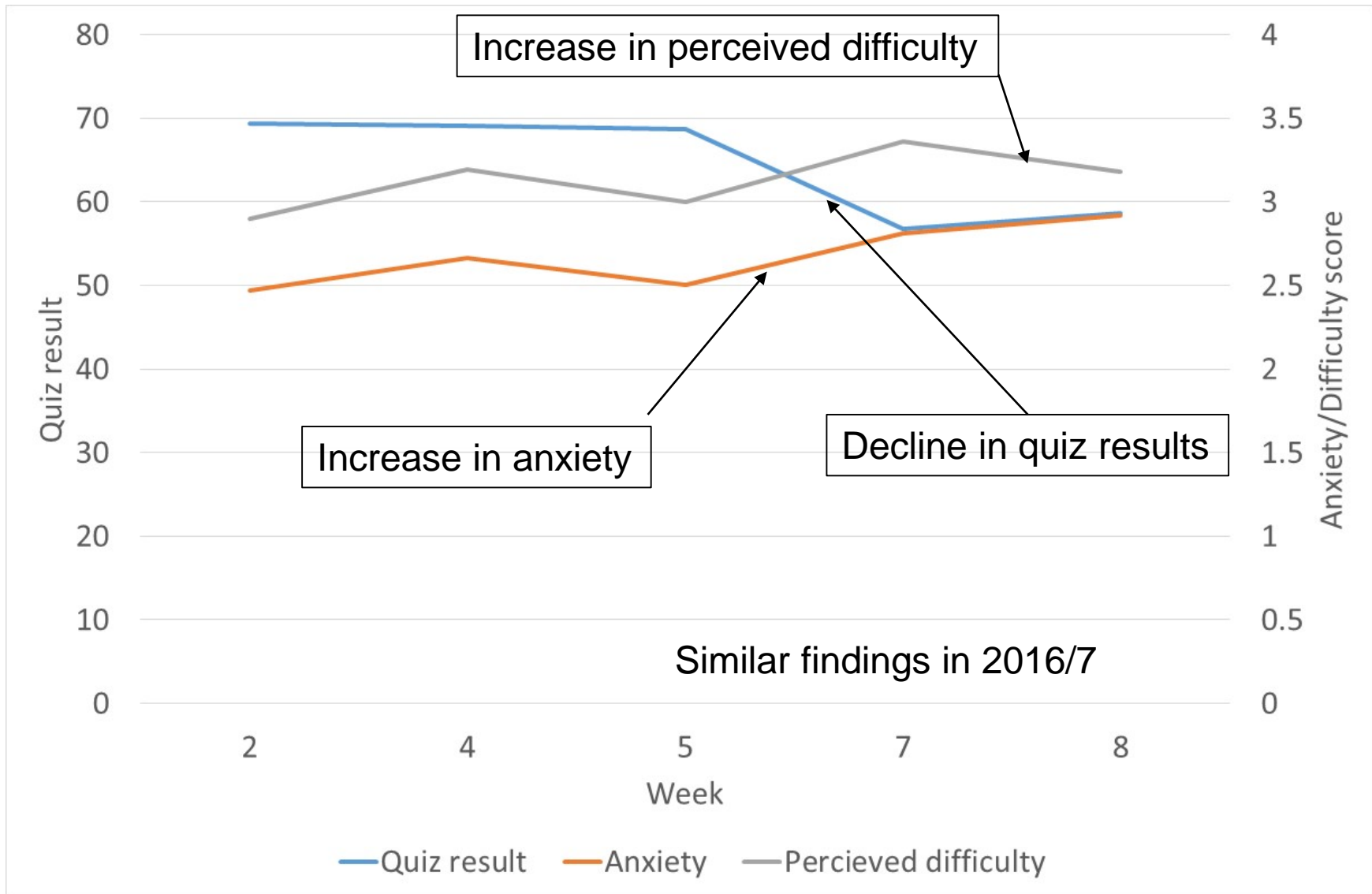
- Tutorial attendance strongly correlated with both assessment scores
  - In part related to characteristics of students who miss tutorials (less organised, motivated for example)
  - 20% gap in quiz marks from high to low tutorial attendance in bivariate analysis reduces to 12% in the multivariate model
  - Multivariate models suggests also because of the excellent tutorial material and tutor instruction
  - Role of tutorials (and tutors) in Q-Step courses should not be underestimated
  - Investment of resources in tutorials (and tutors) within social statistics course very worthwhile



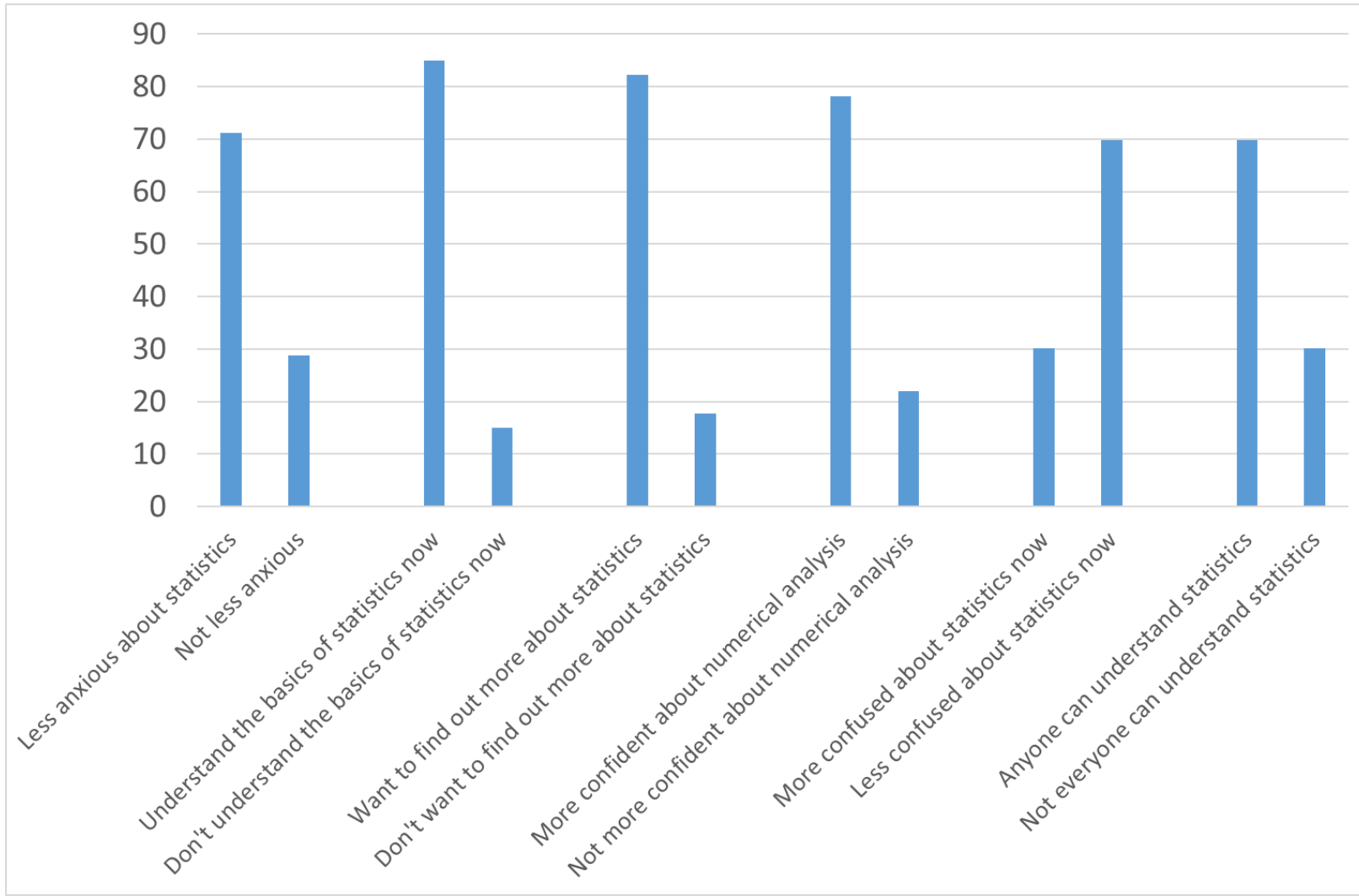
## Comments on tutorials: qualitative feedback

- “Tutorials are very well run and helpful”.
- “Despite the fact that I have no background of statistics I find that even in the midterm of the course I understood most of the topics introduced in the course”.
- “The tutorials helped me a lot as you have the chance to engage with Excel and undertake formulas and also analyse data of contingency tables, scatterplot diagrams”.
- “I like that my tutor is very friendly and goes through the material step by step in a very clear manner :)”

# Trends in anxiety....Closely related to difficulty of quiz



# While anxiety levels remain high.... Most importantly students are less anxious and more positive about statistics at the end of the course



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