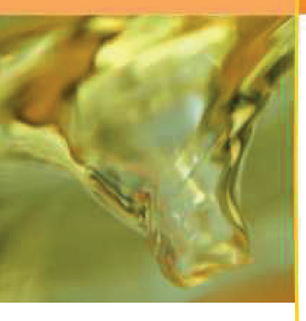
Universiteit Utrecht

Faculty of Science
Department of Mathematics
Freudenthal Institute
www.uu.nl/science/



Students' interpretations of histograms: a review

Lonneke Boels[1,2], Arthur Bakker[1], Paul Drijvers[1], Wim van Dooren[3]

[1]Utrecht University, [2]Christelijk Lyceum Delft, [3]KU Leuven

Motive

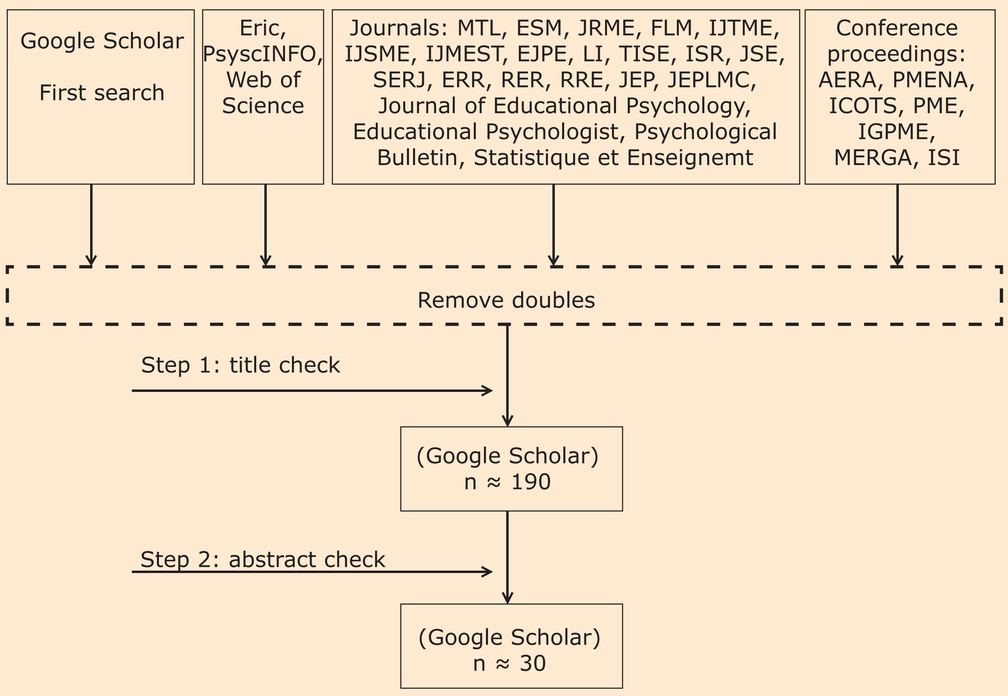
Students make several mistakes when interpreting graphs with statistical data even with seemingly simple graphs such as histograms, for example when comparing two graphs (Friel, Curcio, & Bright, 2001; Lem et al., 2013). This review is a first step in revealing possible causes of students' difficulties with histograms.

Theoretical framework

The theoretical framework is used to categorize the mistakes students make with interpreting and drawing inferences from histograms. Mistakes can be categorizes in three levels: 'read the data', 'read between the data' and 'read beyond the data' (Friel et al., 2001).

Figure 2

Overview of the search process.



Methods

In this systematic review an inventory is made of all kinds of mistakes students make when interpreting and drawing inferences from histograms. A protocol of the review study is available on request.

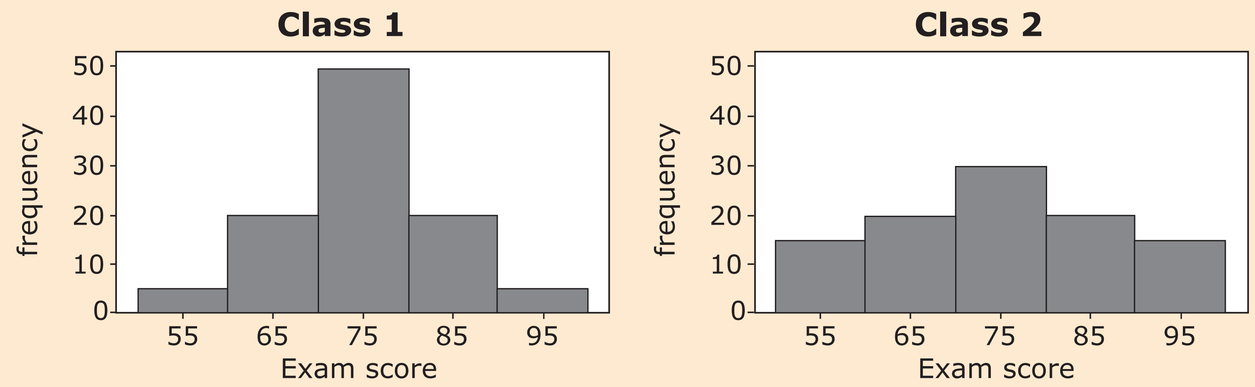


Figure 1

Students are asked in which class the spread in exam scores is bigger. Often chosen answer: class 1. Correct answer: class 2 (Cooper & Shore, 2008, 2010). Reproduced with the kind permission of L.L. Cooper. Possible cause of the mistake: students look at the height differences of the bars.

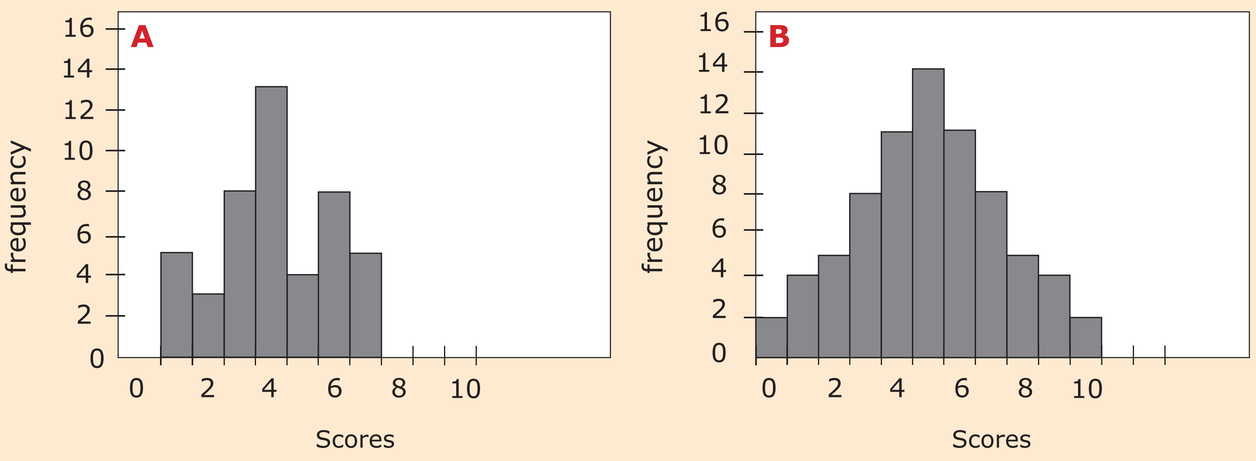


Figure 3

Which distribution has more variability? This question is used in many studies (Ben-Zvi & Makar, 2016). For example in Meletiou-Mavrotheris & Lee (2005) 45% of the students chose answer A instead of the correct answer B. Possible cause of the mistake: students probably took the differences between frequencies into account rather then the spread in the scores values.

Preliminary results

Identified mistakes:

a) Higher histogram so more spread (Cooper & Shore, 2008, 2010).
b) Horizontal: time scale (Meletiou, 2000).
c) Shape of the bar graph is a bell thus it is a histogram (delMas, 2007)
d) No distinction between histogram and bar graph (Kaplan, Gabrosek, Curtiss, & Malone, 2014)
e) Use of frequency (y-axis) to determine the median and modal group (Kaplan, Gabrosek, Curtiss, & Malone, 2014)
f) Variability often misunderstood (Meletiou-Mavrotheris & Lee, 2005)

Preliminary conclusions

1. **Most of the difficulties students have with interpreting histograms occur at the level of 'read between' and 'beyond the data'. An example is shown in figures 1 and 3. Students often give correct answers on questions that ask to 'read the data'.**
2. **Several mistakes students make persist after a course in statistics (Kaplan, Gabrosek, Curtiss, & Malone, 2014).**
3. **A possible cause of mistakes is that students look at the height differences of the bars only (Lem et al., 2014).**

References

1. Ben-Zvi, D., & Makar, K. (Eds.) (2016). *The teaching and learning of statistics. International perspectives.* Heidelberg: Springer.
2. Cooper, L. L., & Shore, F. S. (2008). Students' Misconceptions in interpreting center and variability of data represented via histograms and stem-and-leaf plots. *Journal of Statistics Education, 16*(2), 1-13.
3. Cooper, L., & Shore, F. (2010). The effects of data and graph type on concepts and visualizations of variability. *Journal of Statistics Education, 18*(2), 1-16.
4. delMas, R., Garfield, J., Ooms, A., & Chance, B. (2007). Assessing students' conceptual understanding after a first course in statistics. *Statistics Education Research Journal, 6*(2), 28-58.
5. Friel, S. N., Curcio, F. R., & Bright, G. W. (2001). Making sense of graphs: critical factors influencing comprehension and instructional implications. *Journal for Research in Mathematics Education, 32*(2), 124-158.
6. Kaplan, J. J., Gabrosek, J. G., Curtiss, P., & Malone, C. (2014). Investigating student understanding of histograms. *Journal of Statistics Education, 22*(2), 1-30.
7. Lem, S., Onghena, P., Verschaffel, L., & Van Dooren, W. (2013). On the misinterpretation of histograms and box plots. Educational Psychology: *An International Journal of Experimental Educational Psychology, 33*(2), 155-174.
8. Lem, S., Onghena, P., Verschaffel, L., & Van Dooren, W. (2014). Interpreting histograms. As easy as it seems? *European Journal of Psychology Education, 29*(4), 557-575.
9. Meletiou, M. (2000). *Developing students' conceptions of variation: an untapped well in statistical reasoning.* Austin: University of Texas.
10. Meletiou-Mavrotheris, M., & Lee, C. (2005). *Exploring introductory statistics students' understanding of variation in histograms.* Paper presented at the fourth congress of ERME, the European society for research in mathematics education, Sant Feliu de Guíxols, Spain.