

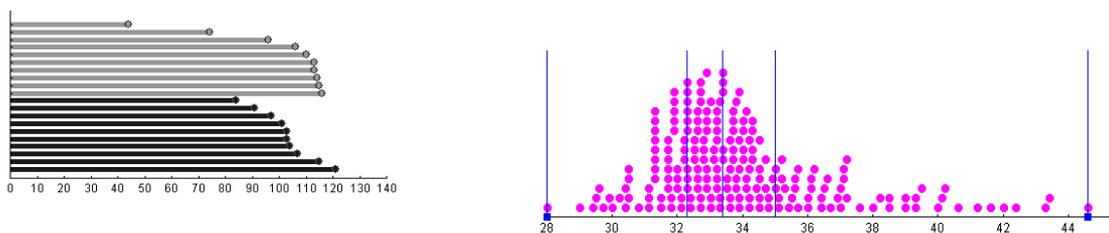
## STATISTICAL MINITOOLS IN A LEARNING TRAJECTORY

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The three demonstrated statistical minitools are Java applets that can run via the Internet (e.g. [www.fi.uu.nl/~arthur](http://www.fi.uu.nl/~arthur)), but are also available as stand-alone applications. They have been designed for teaching experiments in grade 7 and 8 for Cobb, McClain and Gravemeijer of the Vanderbilt University (USA), and are now used for Dutch experiments of Bakker in grade 7.

At first sight, user-friendly data-analysis software packages seem to be the self-evident accessories for exploratory data analysis. However, working with such packages rather signifies an end point of the intended instructional sequence than a means of supporting it. Instead of using ready-made statistical tools, the present minitool sequence incorporates software tools that can be used for *learning* exploratory data analysis.

The point of departure is a bottom-up approach in which the minitools are perceived by the students as sensible tools that are compatible with their actual conception of analyzing data. For the students, the primary function of the minitools is to help them structure and describe data sets in order to make a decision or judgement. In this process, notions such as mean, mode, median, skewness, spreadoutness, and frequency may emerge as ways of describing how specific data are distributed within this space of values. Further in this approach, various statistical representations or inscriptions like histogram and box plot may emerge as means of structuring or describing distributions. In fact, the minitools are so designed, that they can support a process of progressive mathematization by which conventional statistical concepts and representations are reinvented.



*Figure. Minitool 1 and 2: value bar graph and stacked dot plot.*

In minitool 1 every measurement is displayed as a bar. The data can be sorted and investigated with several tools. While working on problems with the simple bar representations, the students learn to relate characteristics of the graphs to the meaning within the context of the problem. If this relationship is consolidated, a more advanced representation is used: not bars but dots in a stacked dot plot are used, the representation of minitool 2. The data in minitool 2 can be organized in several ways, e.g. make your own groups, fixed interval width, two and four equal groups. The last three are useful precursors to histogram, median and box plot. Later, the students can go on with minitool 3, which offers a multi-dimensional scatter plot with several grouping options.