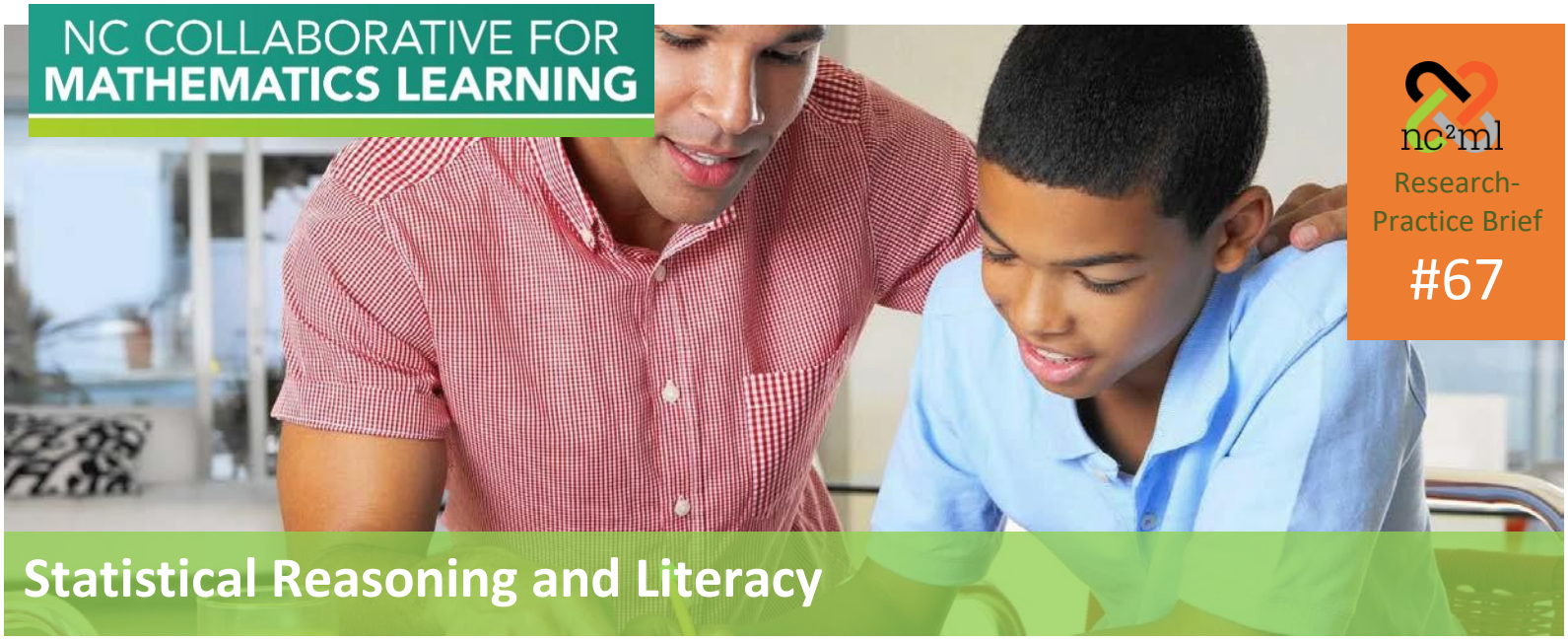
NC COLLABORATIVE FOR MATHEMATICS LEARNING



nc²ml Research-Practice Brief #67

Statistical Reasoning and Literacy

THE IMPORTANCE OF STATISTICAL REASONING AND LITERACY

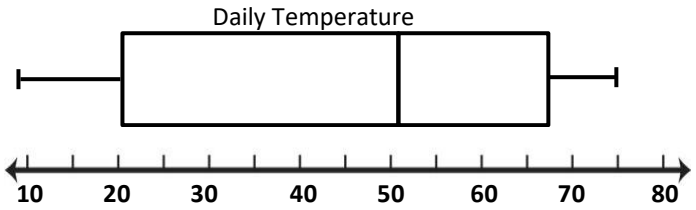
Engaging students in statistical reasoning is an important aspect of all the statistics and probability content standards in grades 6-8. Statistical reasoning is a problem solving process not a product. It is a process of making sense of statistical information and tasks situated in real-world contexts with real data (Franklin et al., 2007). This involves making sense of data, data representations, and statistical results as well as making connections between concepts as part of doing so. Statistical reasoning is not about teaching students a set of skills, procedures, and computations (Ben-Zvi & Garfield, 2004). Merely computing and reporting descriptive statistics alone is not statistical reasoning; in other words, calculating the mean, median and mode of a set of data is an important *skill* that is necessary for analyzing and creating a statistical argument, but is not reasoning statistically in and of itself. Using the measures of center and spread to describe the variability of a distribution and answer a statistical question is statistical *reasoning*.

Statistical literacy, on the other hand, is the ability to understand and assess statistical data, including graphs and other representations that appear in everyday life in order to make and communicate informed decisions as a global citizen (Gal, 2002; Wallman, 1993). The major distinction between statistical reasoning and literacy is the difference between being a statistics producer and a statistics consumer. The two have overlap, of course, in that knowledge of statistical terms and representations, data analysis techniques and concepts of randomness and sampling is needed. According to Gal (2000), a statistically literate student will be able to review a report and discuss the type of study conducted, the sample selected, the measurements made, statistics generated, pictorial displays used, probability statements made, claims suggested and limitations of the study.

Task for Discussion

How would you change the task below to provide more opportunity for students to reason statistically?

The box plot below shows the daily average temperature on an island over a 360 day period.



a. What is the median temperature?
b. What is the maximum temperature?
c. What is the IQR?
d. How many days was the temperature between 20 km/h and 51 km/h?

TIME IS OF THE ESSENCE

The need for both statistical reasoning and literacy has never been as critical as today given that an increasing number of jobs utilize statistical information and reasoning.

Additionally, statistical data, test results, and representations are presented ad nauseam in newspapers and on new channels as a way to justify legislative policies and procedures as well as poll results for political elections. Statistical reasoning and literacy can no longer be relegated to the last unit of the semester or not addressed at all.

HOW IS STATISTICAL REASONING DIFFERENT THAN MATHEMATICAL REASONING?

Statistical reasoning is different than mathematical reasoning in that statistical reasoning includes the presence of data, situated in a

context, contains variability, and is focused on inductive (inferential) reasoning. In statistics, data are viewed as numbers associated with a context, and the context motivates the analysis and statistical methods that are used. In mathematics, the numbers are not always presented in context and are typically precise and finite, as opposed to the messiness of statistical data. Statistical reasoning involves starting with a question about a context and has multiple solutions/opinions guided by certain findings and assumptions.

WHAT STATISTICAL REASONING IS NOT

Warning One: **Being proficient at statistical calculations does NOT mean a student is reasoning statistically**. While it is important to learn the calculations for finding averages, merely calculating them does not indicate understanding of those statistics, especially since technology can do so more efficiently. It is more important to understand what it means and how it is used to make a statistical argument.

Warning Two: **Formulas and procedures themselves do not help students learn to reason statistically**. For example, being able to create a box plot and report the five number summary does not indicate an intuitive understanding that a box plot represents a multiplicative representation ("quartering" of the data).

Warning Three: **Knowing and using statistical vocabulary does not necessarily indicate students are reasoning statistically**. Granted, using statistics vocabulary appropriate is essential to statistical reasoning and literacy, but without an understanding of their meaning, is useless.

STATISTICS ACROSS MIDDLE SCHOOL

In *Developing Essential Understandings of Statistics*, Kader and Jacobbe (2013) outline four big ideas for students to learn about statistics in grades 6-8, which include:

- Distributions describe variability in data.
- Statistics can be used to compare two or more groups of data.
- Bivariate distributions describe patterns or trends in the co-variability in data on two variables.
- Inferential statistics uses data in a sample selected from a population to describe features of the population.

Similarly, the NC Standard Course of Study, students begin middle school by developing the notion of a univariate distribution and how to describe its variability through different measures of center and informal ideas of spread. Box plots and histograms are introduced as new representations for distributions. Central to these two ideas is learning what types of questions qualify as statistical. This is followed by then expanding these ideas to comparing two or more groups of data by using ideas of variability described in distributions. Crucial to statistical explorations in grade 7 is understanding the difference between a sample and population and learning how to obtain a representative sample in order to make inferences. The focus then in grade 8 is to consider bivariate data, looking for patterns and trends between two variables on the same sample or things being observed. The notion of inferential statistics should be threaded across all grade levels in an informal manner. Conducting formal inferential hypothesis testing or creating confidence intervals is not the goal in middle school. The focus rather is to engage students in statistical reasoning about sample distributions and their variability and how characteristics of sample distributions and their statistical measures can be used to make inferences about the populations they represent (Kader & Jacobbe, 2013).

References

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NC²ML MATHEMATICS ONLINE

For more information and resources please visit the NC DPI math wiki for instructions on accessing our Canvas page created in partnership with the North Carolina Department of Public Instruction by http://maccss.ncdpi.wikispaces.net/

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