## Practice 4  Analyzing and Interpreting Data

*Once collected, data must be presented in a form that can reveal any patterns and relationships and that allows results to be communicated to others. Because raw data as such have little meaning, a major practice of scientists is to organize and interpret data through tabulating, graphing, or statistical analysis. Such analysis can bring out the meaning of data—and their relevance—so that they may be used as evidence.*

*Engineers, too, make decisions based on evidence that a given design will work; they rarely rely on trial and error. Engineers often analyze a design by creating a model or prototype and collecting extensive data on how it performs, including under extreme conditions. Analysis of this kind of data not only informs design decisions and enables the prediction or assessment of performance but also helps define or clarify problems, determine economic feasibility, evaluate alternatives, and investigate failures.* (NRC Framework, 2012, p. 61-62)

As students mature, they are expected to expand their capabilities to use a range of tools for tabulation, graphical representation, visualization, and statistical analysis. Students are also expected to improve their abilities to interpret data by identifying significant features and patterns, use mathematics to represent relationships between variables, and take into account sources of error. When possible and feasible, students should use digital tools to analyze and interpret data. Whether analyzing data for the purpose of science or engineering, it is important students present data as evidence to support their conclusions.

| Grades K-2 | Grades 3-5 | Grades 6-8 | Grades 9-12 |
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| Analyzing data in K–2 builds on prior experiences and progresses to collecting, recording, and sharing observations. <br>• Record information (observations, thoughts, and ideas). <br>• Use and share pictures, drawings, and/or writings of observations. <br>• Use observations (firsthand or from media) to describe patterns and/or relationships in the natural and designed world(s) in order to answer scientific questions and solve problems. <br>• Compare predictions (based on prior experiences) to what occurred (observable events). <br>• Analyze data from tests of an object or tool to determine if it works as intended. | Analyzing data in 3–5 builds on K–2 experiences and progresses to introducing quantitative approaches to collecting data and conducting multiple trials of qualitative observations. When possible and feasible, digital tools should be used. <br>• Represent data in tables and/or various graphical displays (bar graphs, pictographs and/or pie charts) to reveal patterns that indicate relationships. <br>• Analyze and interpret data to make sense of phenomena, using logical reasoning, mathematics, and/or computation. <br>• Compare and contrast data collected by different groups in order to discuss similarities and differences in their findings. <br>• Analyze data to refine a problem statement or the design of a proposed object, tool, or process. <br>• Use data to evaluate and refine design solutions. | Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis. <br>• Construct, analyze, and/or interpret graphical displays of data and/or large data sets to identify linear and nonlinear relationships. <br>• Use graphical displays (e.g., maps, charts, graphs, and/or tables) of large data sets to identify temporal and spatial relationships. <br>• Distinguish between causal and correlational relationships in data. <br>• Analyze and interpret data to provide evidence for phenomena. <br>• Apply concepts of statistics and probability (including mean, median, mode, and variability) to analyze and characterize data, using digital tools when feasible. <br>• Consider limitations of data analysis (e.g., measurement error), and/or seek to improve precision and accuracy of data with better technological tools and methods (e.g., multiple trials). <br>• Analyze and interpret data to determine similarities and differences in findings. <br>• Analyze data to define an optimal operational range for a proposed object, tool, process or system that best meets criteria for success. | Analyzing data in 9–12 builds on K–8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data. <br>• Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. <br>• Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible. <br>• Consider limitations of data analysis (e.g., measurement error, sample selection) when analyzing and interpreting data. <br>• Compare and contrast various types of data sets (e.g., self-generated, archival) to examine consistency of measurements and observations. <br>• Evaluate the impact of new data on a working explanation and/or model of a proposed process or system. <br>• Analyze data to identify design features or characteristics of the components of a proposed process or system to optimize it relative to criteria for success. |