Investigations in Number, Data, and Space®

Math Content by Strand[1]

Data Analysis

Kindergarten

Sorting and classifying are central to organizing and interpreting data. Students in Kindergarten have many opportunities to identify the attributes of groups of objects, determine how the objects are the same and different and sort them into groups according to their attributes. Students apply these skills to organizing data when they sort their favorite lunch foods into categories.

One way students sorted their lunch data.

[1] This document applies to the 2nd edition of *Investigations* (2008, 2012). See http://investigations.terc.edu/CCSS/ for changes when implementing *Investigations and the Common Core Standards*.

Students think about how these pieces of information are the same and different in order to determine how the data might be grouped and how those groups can be defined.

Important to any data collection activity is the need to establish the group of people or objects being considered. Students begin their work on data by determining the number of students in the class and finding a way to represent this number on paper. As students collect data about themselves, they think about the one to one correspondence between the number of people and the number of pieces of data. Developing strategies for keeping track of who has responded to a survey, recording data, as well as representing this information, are important parts of the Kindergarten work.

To begin to understand the processes involved in data analysis, Kindergarteners are involved in all phases of conducting a survey: They choose and pose a question, determine how to record responses, and count and make sense of the results.

Example: Do you like  **?**

Yes	No
Carmen	Dennis
Mitchell	Timothy
Mary	Sarah
Tammy	Lisa
Raul	Kiyo
Jennifer	Latoya
	Lionel
	Manuel
	Yoshio
	Beth
	Russell

Students also use some of the data they collect to solve mathematical problems connected to their classroom. For example,

"25 students are in our class. 4 are absent. How many are here?"

Emphases

Data Analysis

- Representing Data
- Sorting and Classifying
- Carrying Out a Data Investigation

Benchmarks

- Represent a set of data
- Use data to solve a problem
- Sort a set of objects according to their attributes

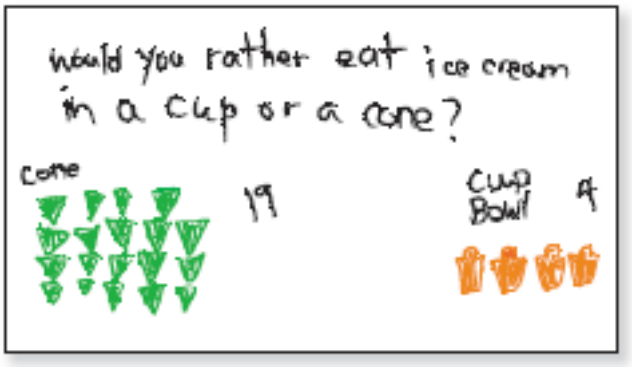
Grade 1

In first grade, students sort groups of related objects, such as buttons, into groups, and describing what distinguishes one group from another. This early work in classification provides experience in considering only certain attributes of an object while ignoring others. Sorting a variety of sets lays the foundation for later work in classifying shapes and numbers and in working with categorical data.

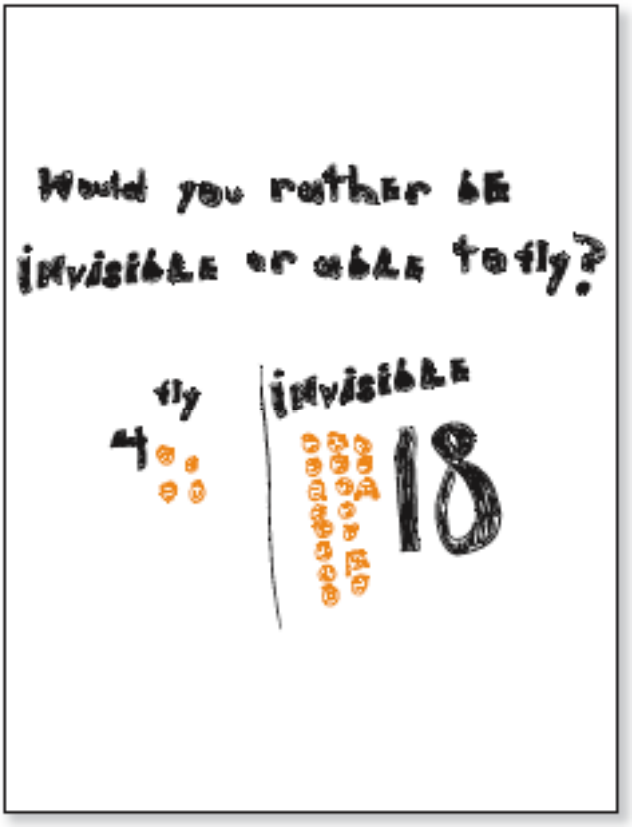
A student sorts a set of buttons into two groups: "fancy" and "not fancy."

First graders create their own representations of the data they collect, organizing their data and providing an image that helps them describe what the data show. Students are also introduced to several standard forms of representation, including picture graphs, tallies, charts, and bar graphs. By discussing and comparing representations, students consider what features of a representation help communicate a clear description of the data. As student describe data, the key question they consider is: What do these data tell us about our class [or the class next door, or our siblings]?

In the context of this overall question, first graders' descriptions focus on two characteristics of the data: (1) "What is the number of pieces of data in each category or at each value?" and (2) "Which category has more data?"



Would you rather eat ice cream in a cup or in a cone?



Would you rather be invisible or be able to fly?

Students carry out their own data investigation. They develop a question, collect the data, represent the data, and describe and interpret the data, which may, in turn, bring up more questions. Once data are collected, the data are represented, examined, and analyzed to find out what information the data provide about the original questions.

Emphases

Data Analysis

- Sorting and Classifying
- Representing Data
- Describing Data
- Designing and Carrying Out a Data Investigation

Benchmarks

- Sort a group of objects according to a given attribute
- Represent a set of data with two categories
- Interpret a variety of representations of data with two categories
- Describe a set of data including how many are in each group, which group is greater, and how many people responded to the survey

Grade 2

Students' work on data begins with sorting activities in which they sort objects by their attributes, describing what distinguishes one group from another. This early work in classification provides experience in considering only certain attributes of an object while ignoring others. Students then apply these ideas to categorical data. They *classify* data with many different values, for example the responses to the question, "What is your favorite weekend activity?" by grouping the data into categories (outdoor and indoor activities; or things you do by yourself, things you do with one friend, and things you do with a group). By grouping the data in different ways, students can use the same data to answer different questions.

Example: What is your favorite activity to do on the weekend?

Indoor	Outdoor
reading	soccer
playing board games	walking my dog
	playing basketball

Alone	With More Than 1 Person
reading	soccer
walking my dog	playing basketball
	playing board games

Students use a variety of representations: Venn diagrams, towers of cubes, line plots, and their own representations.

By comparing a variety of representations of the same data, they learn how different representations can make different aspects of the data set more visible. Students are introduced to line plots and other frequency distributions in which each piece of data is represented by one symbol (e.g., an X, a square, or a stick-on note). In using this kind of representation, students have to think through the meaning of two ways numbers are used in describing the data: Some numbers indicate the value of a piece of data (I have *8 pockets*); other numbers indicate *how often* a particular data value occurs (*7 children* have 8 pockets). Students describe data by considering the number of pieces of data that occur at each value, the mode and the highest and lowest values.

Through experiencing an entire data investigation from start to finish, students encounter many of the same issues encountered by statisticians as they decide how to collect, keep track of, organize, represent, describe, and interpret their data. They develop their own survey questions about "favorite things", and collect and organize the survey data. They also collect data from different grades about the number of teeth lost and represent and compare these data to their own class data.

Emphases

Data Analysis

- Sorting and Classifying Data
- Representing Data
- Describing Data
- Designing and Carrying Out a Data Investigation

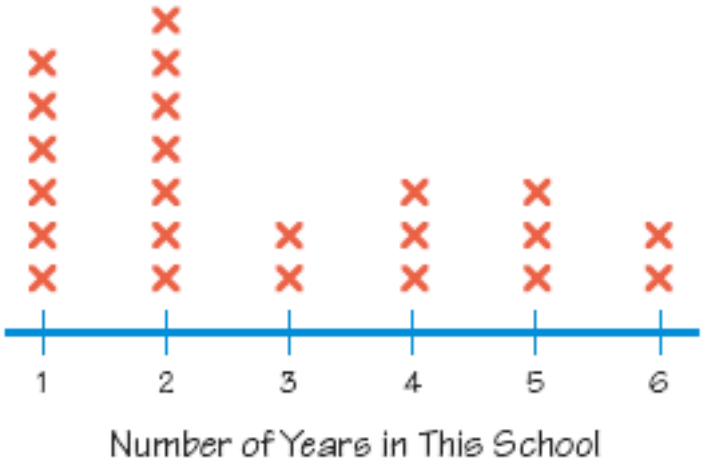
Benchmarks

- Use a Venn diagram to sort data by two attributes
- Identify categories for a set of categorical data and organize the data into the chosen categories
- Order and represent a set of numerical data
- Describe a numerical data set, including the highest and lowest values and the mode
- Read and interpret a variety of representations of numerical and categorical data
- Compare two sets of numerical data

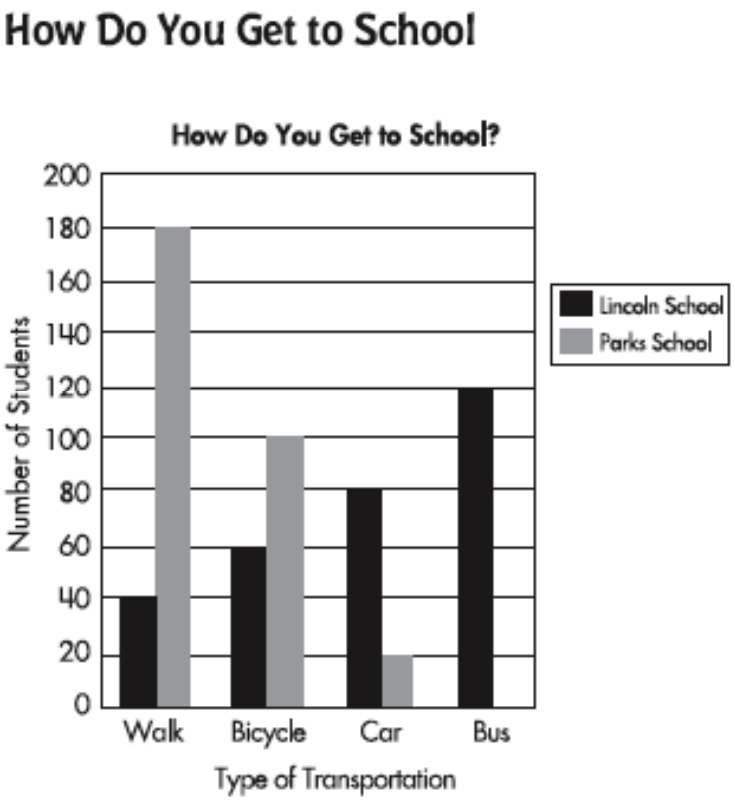
Grade 3

Students collect, represent, describe, and interpret data. They work with both categorical and numerical data, and consider how to look at a data set as a whole and make statements about the whole group. In order to make sensible statements about a categorical data set that has many different values, students group the data into categories that help them see the data as a whole. Students order numerical data by value so that

they can see the shape of the data—where the data are concentrated, where they are spread out, which intervals have many pieces of data, and which have very few. They describe what values would be typical or atypical, based on the data, and compare data sets in order to develop a sense of how data can be useful in describing and comparing some characteristic of a group.



Students work with their own data, creating representations, and then comparing and discussing these representations. Students use double bar graphs to compare groups, including some in which the scales have intervals greater than 1.



Students interpret line plots and create their own line plots to represent numerical data. By conducting their own data investigations, students consider how the question they pose and the way they conduct their study affect the resulting data.

Emphases

Data Analysis

- Describing, summarizing, and comparing data
- Representing data
- Designing and carrying out a data investigation

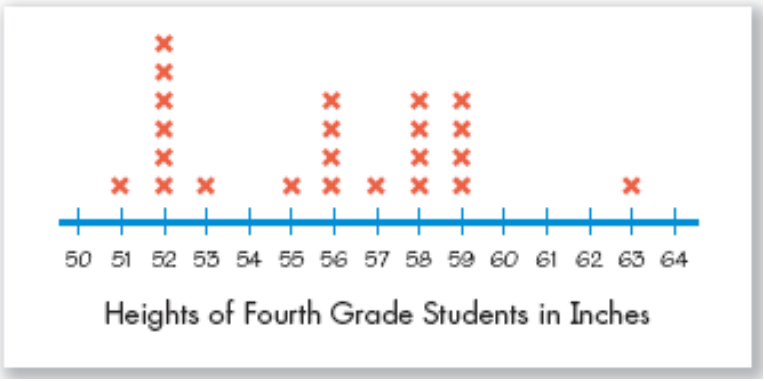
Benchmarks

- Organize, represent, and describe categorical data, choosing categories that help make sense of the data
- Interpret a bar graph
- Make a line plot for a set of numerical data
- Describe the shape of the data for a numerical data set, including where data are concentrated, where there are few data, what the lowest and highest values are, what the mode is, and where there is an outlier
- Summarize a set of data, describing concentrations of data and what those concentrations mean in terms of the situation the data represent

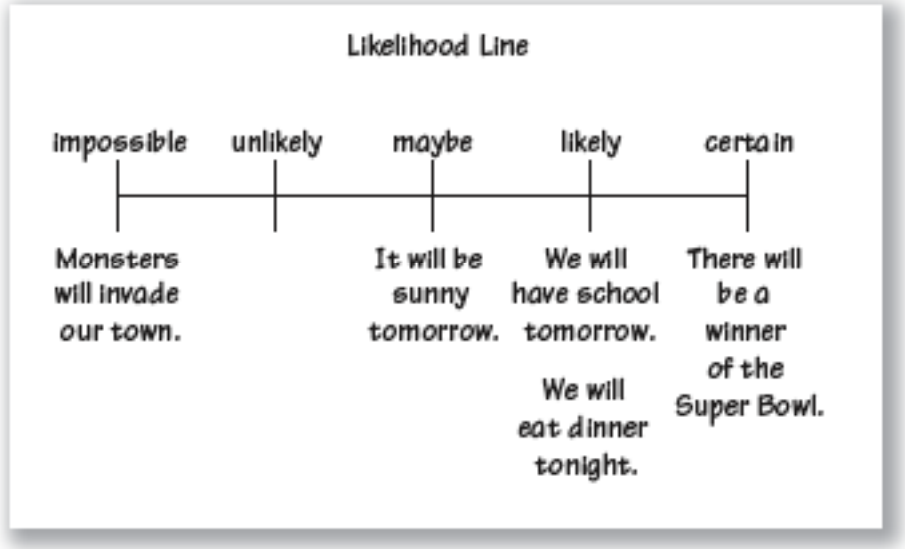
Data Analysis and Probability

Grade 4

Students continue to develop their understanding of data analysis by collecting, representing, describing, and interpreting numerical data, in order to answer a question, investigate an issue, or provide information about something in the world that is of interest. Their work focuses on describing and summarizing data for comparing two groups. Using a *line plot* as a tool for showing the shape or distribution of a set of data—where the data are concentrated, how they are spread across the range—students represent data about two groups, and then consider how to characterize how the groups are similar or different. They develop conclusions and make arguments, based on the evidence they have collected.



Students also work on describing and predicting the likelihood of events in their world: what events are impossible, unlikely, likely, or certain? They consider situations in which there is a known number of possible outcomes—such as when rolling a number cube or pulling a red cube out of a bag holding a certain number of red and blue cubes. Students reason about how the theoretical chance (or *theoretical probability*) of, for example, rolling 1 on a number cube compares to what actually happens when a number cube is rolled repeatedly.



Emphases

Data Analysis

- Representing data
- Describing, summarizing, and comparing data
- Analyzing and interpreting data
- Designing and carrying out a data investigation

Probability

- Describing the probability of an event

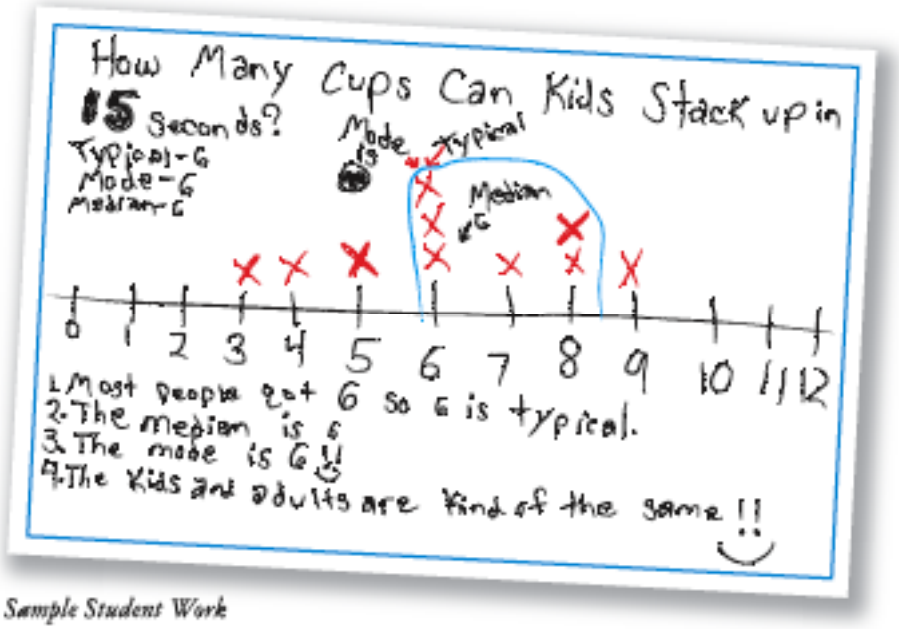
Benchmarks

- Design an effective survey question to compare two groups
- Organize and represent data about two groups in order to compare the groups
- Describe the shape of the data from a numerical data set including where the data are concentrated and the highest, lowest and median values
- Use data to compare two groups
- Use evidence from a set of data to support an argument
- Describe the likelihood of an event in terms of a scale from impossible (probability of 0) to certain (probability of 1)

Data Analysis and Probability

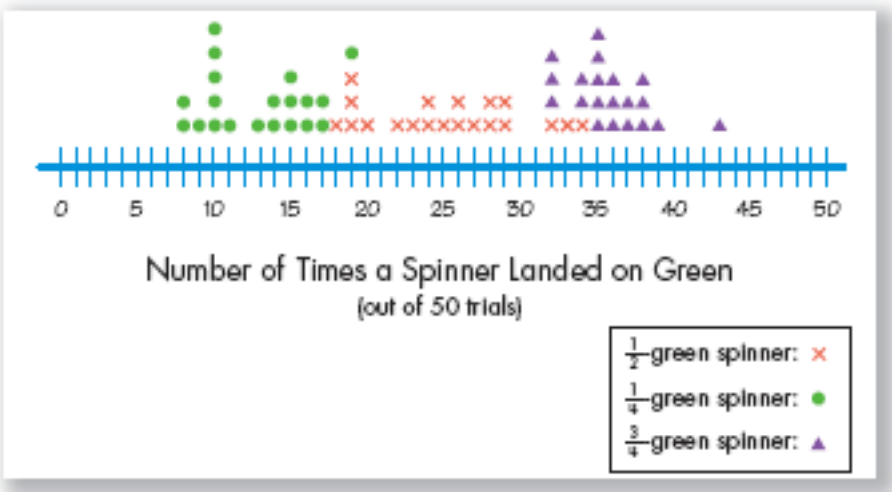
Grade 5

Students continue to develop their understanding of data analysis in Grade 5 by collecting, representing, describing, and interpreting numerical data. Students' work in this unit focuses on comparing two sets of data collected from experiments. Students develop a question to compare two groups, objects, or conditions. (Sample questions: Which toy car goes farthest after rolling down the ramp? Which paper bridge holds more weight?). They consider how to ensure a consistent procedure for their experiment and discuss the importance of multiple trials. Using representations of data, including line plots and bar graphs, students describe the shape of the data—where the data are concentrated, how they are spread across the range. They summarize the data for each group or object or condition and use these summaries, including medians, to back up their conclusions and arguments. By carrying out a complete data investigation, from formulating a question through drawing conclusions from their data, students gain an understanding of data analysis as a tool for learning about the world.



Sample Student Work

In their work with probability, students describe and predict the likelihood of events and compare theoretical probabilities with actual outcomes of many trials. They use fractions to express the probabilities of the possible outcomes (e.g., landing on the green part of the spinner, landing on the white part of the spinner). Then they conduct experiments to see what actually occurs. The experiments lead to questions about theoretical and experimental probability, for example, if half the area of a spinner is colored green and half is colored white, why doesn't the spinner land on green exactly half the time?



Emphases

Data Analysis

- Representing data
- Describing, summarizing, and comparing data
- Analyzing and interpreting data

- Designing and carrying out a data investigation

Probability

- Describing the probability of an event
- Describe major features of a set of data represented in a line plot or bar graph, and quantify the description by using medians or fractional parts of the data

Benchmarks

- Draw conclusions about how 2 groups compare based on summarizing the data for each group
- Design and carry out an experiment in order to compare two groups
- Use a decimal, fraction, or percent to describe and compare the theoretical probabilities of events with a certain number of equally likely outcomes