Washington State K–8 Mathematics Standards
April 2008

Data Analysis, Statistics, and Probability Strand

In kindergarten through grade 5, students learn a variety of ways to display data, and they interpret data to answer questions. Students in grades 3–5 relate what they are learning about fractions to describe the likelihood of something happening. In grades 6–8, students use a more extensive set of tools to summarize and analyze data sets, and they extend their work with probability. In grades 9–12, students use more sophisticated tools to represent, describe, and compare data sets, and they analyze statistical studies and findings to determine whether conclusions are sound.

This is one of six strand documents that accompany the Washington State K–8 Mathematics Standards, tracking the development of important mathematical ideas and skills across grades K–8. Where content of an expectation may address more than one strand, that expectation may appear in more than one strand document.

Grade 1

1.5. Additional Key Content

Performance Expectations	*Explanatory Comments and Examples*
Students are expected to:	
1.5.A Represent data using tallies, tables, picture graphs, and bar-type graphs.	In a picture graph, a single picture represents a single object. Pictographs, where a symbol represents more than one unit, are introduced in grade three when multiplication is developed. Students are expected to be familiar with all representations, but they need not use them all in every situation.
1.5.B Ask and answer comparison questions about data.	Students develop questions that can be answered using information from their graphs. For example, students could look at tallies showing the number of pockets on pants for each student today. Andy 𝍸 | Sara |||| Chris 𝍸 They might ask questions such as: — Who has the most pockets? — Who has the fewest pockets? — How many more pockets does Andy have than Chris?

Grade 2

2.4. Additional Key Content

Performance Expectations	*Explanatory Comments and Examples*
Students are expected to:	
2.4.B Collect, organize, represent, and interpret data in bar graphs and picture graphs.	In a picture graph, a single picture represents a single object. Pictographs, where a symbol represents more than one unit, are introduced in grade three when multiplication skills are developed.

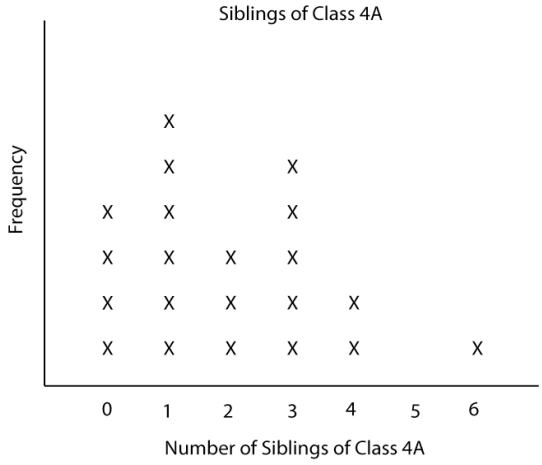
Grade 3

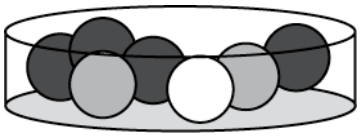
3.4. Additional Key Content

Performance Expectations	*Explanatory Comments and Examples*
Students are expected to:	
3.5.E Construct and analyze pictographs, frequency tables, line plots, and bar graphs.	Students can write questions to be answered with information from a graph. Graphs and tables can be used to compare sets of data. Using pictographs in which a symbol stands for multiple objects can reinforce the development of both multiplication and division skills. Determining appropriate scale and units for the axes of various types of graphs can also reinforce multiplication and division skills.

Grade 4

4.4. Additional Key Content

Performance Expectations	*Explanatory Comments and Examples*
Students are expected to:	
4.4.E Determine the median, mode, and range of a set of data and describe what each measure indicates about the data.	Example: • What is the median number of siblings that students in this class have? What is the mode of the data? What is the range of the number of siblings? What does each of these values tell you about the students in the class? 
4.4.F Describe and compare the likelihood of events.	For this introduction to probability, an event can be described as *certain*, *impossible*, *likely*, or *unlikely*. Two events can be compared as *equally likely*, *not equally likely*, or as one being *more likely* or *less likely* than the other.

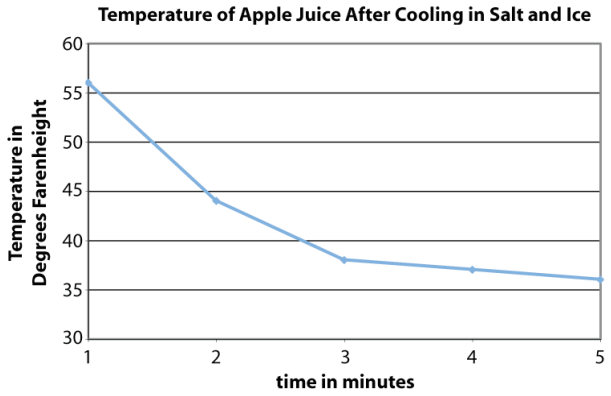
Performance Expectations	Explanatory Comments and Examples
Students are expected to:	
4.4.G Determine a simple probability from a context that includes a picture.	Probability is expressed as a number from 0 to 1. Example: • What is the probability of a blindfolded person choosing a black marble from the bowl? 
4.4.H Display the results of probability experiments and interpret the results.	Displays include tallies, frequency tables, graphs, pictures, and fractions.

Grade 5

5.5. Additional Key Content

Performance Expectations	Explanatory Comments and Examples
Students are expected to:	
5.5.B Determine and interpret the mean of a small data set of whole numbers.	At this grade level, numbers for problems are selected so that the mean will be a whole number. Example: • Seven families report the following number of pets. Determine the mean number of pets per family. 0, 3, 3, 3, 5, 6, and 8 [One way to interpret the mean for this data set is to say that if the pets are redistributed evenly, each family will have 4 pets.] • The heights of five trees in front of the school are given below. What is the average height of these trees? Does this average seem to represent the 'typical' size of these trees? Explain your answer. 3 ft., 4 ft., 4 ft., 4 ft., 20 ft.

Performance Expectations	Explanatory Comments and Examples
Students are expected to:	
5.5.C Construct and interpret line graphs.	Line graphs are used to display changes in data over time. Example: • Below is a line graph that shows the temperature of a can of juice after the can has been placed in ice and salt over a period of time. Describe any conclusions you can make about the data.



Grade 6

6.3. Core Content: *Ratios, rates, and percents*

Performance Expectations	Explanatory Comments and Examples
Students are expected to:	
6.3.F Determine the experimental probability of a simple event using data collected in an experiment.	The term *experimental probability* refers here to the relative frequency that was observed in an experiment. Example: • Tim is checking the apples in his orchard for worms. Selecting apples at random, he finds 9 apples with worms and 63 apples without worms. What is the experimental probability that a given apple from his orchard has a worm in it?
6.3.G Determine the theoretical probability of an event and its complement and represent the probability as a fraction or decimal from 0 to 1 or as a percent from 0 to 100.	Example: • A bag contains 4 green marbles, 6 red marbles, and 10 blue marbles. If one marble is drawn randomly from the bag, what is the probability it will be red? What is the probability that it will not be red?

Grade 7

7.4. Core Content: *Probability and data*

Performance Expectations	***Explanatory Comments and Examples***
Students are expected to:	
7.4.A Represent the sample space of probability experiments in multiple ways, including tree diagrams and organized lists.	The sample space is the set of all possible outcomes. Example: • José flips a penny, Jane flips a nickel, and Janice flips a dime, all at the same time. List the possible outcomes of the three simultaneous coin flips using a tree diagram or organized list.
7.4.B Determine the theoretical probability of a particular event and use theoretical probability to predict experimental outcomes.	Example: • A triangle with a base of 8 units and a height of 7 units is drawn inside a rectangle with an area of 90 square units. What is the probability that a randomly selected point inside the rectangle will also be inside the triangle? • There are 5 blue, 4 green, 8 red, and 3 yellow marbles in a paper bag. Rosa runs an experiment in which she draws a marble from the bag, notes the color on a sheet of paper, and puts the marble back in the bag, repeating the process 200 times. About how many times would you expect Rosa to draw a red marble?
7.4.C Describe a data set using measures of center (median, mean, and mode) and variability (maximum, minimum, and range) and evaluate the suitability and limitations of using each measure for different situations.	As a way to understand these ideas, students could construct data sets for a given mean, median, mode, or range. Examples: • Kiley keeps track of the money she spends each week for two months and records the following amounts: $6.30, $2.25, $43.00, $2.25, $11.75, $5.25, $4.00, and $5.20. Which measure of center is most representative of Kiley's weekly spending? Support your answer. • Construct a data set with five data points, a mean of 24, a range of 10, and without a mode. • A group of seven adults have an average age of 36. If the ages of three of the adults are 45, 30, and 42, determine possible ages for the remaining four adults.

Performance Expectations

Students are expected to:

7.4.D Construct and interpret histograms, stem-and-leaf plots, and circle graphs.

7.4.E Evaluate different displays of the same data for effectiveness and bias, and explain reasoning.

Explanatory Comments and Examples

Example:

- The following two bar graphs of the same data show the number of five different types of sodas that were sold at Blake High School. Compare and contrast the two graphs. Describe a reason why you might choose to use one graph over the other.

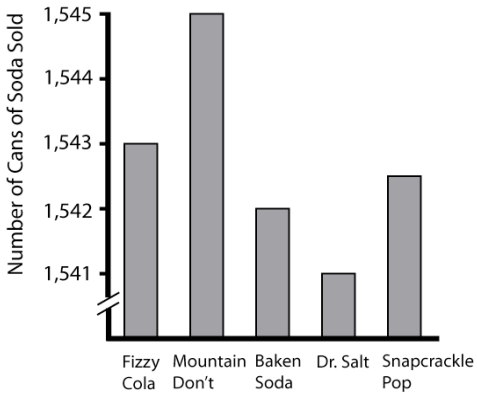


Figure 1

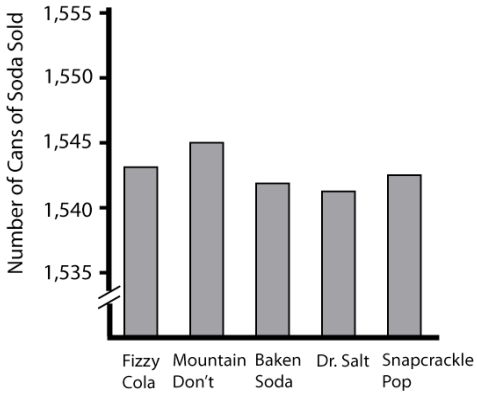


Figure 2

Grade 8

8.3. Core Content: *Summary and analysis of data sets*

Performance Expectations	***Explanatory Comments and Examples***
Students are expected to:	
8.3.A Summarize and compare data sets in terms of variability and measures of center.	Students use mean, median, mode, range, and interquartile range to summarize and compare data sets, and explain the influence of outliers on each measure. Example: • Captain Bob owns two charter boats, the *Sock-Eye-To-Me* and *Old Gus*, which take tourists on fishing trips. On Saturday, the *Sock-Eye-To-Me* took four people fishing and returned with eight fish weighing 18, 23, 20, 6, 20, 22, 18, and 20 pounds. On the same day, *Old Gus* took five people fishing and returned with ten fish weighing 38, 18, 12, 14, 17, 42, 12, 16, 12, and 14 pounds. Using measures of center and variability, compare the weights of the fish caught by the people in the two boats. Make a summary statement telling which boat you would charter for fishing based on thse data and why. What influence, if any, do outliers have on the particular statistics for these data?
8.3.B Select, construct, and analyze data displays, including box-and-whisker plots, to compare two sets of data.	Previously studied displays include stem-and-leaf plots, histograms, circle graphs, and line plots. Here these displays are used to compare data sets. Box-and-whisker plots are introduced here for the first time as a powerful tool for comparing two or more data sets. Example: • As part of their band class, Tayla and Alyssa are required to keep practice records that show the number of minutes they practice their instruments each day. Below are their practice records for the past fourteen days: Tayla: 55, 45, 60, 45, 30, 30, 90, 50, 40, 75, 25, 90, 105, 60 Alyssa: 20, 120, 25, 20, 0, 15, 30, 15, 90, 0, 30, 30, 10, 30

Performance Expectations

Students are expected to:

Explanatory Comments and Examples

Of stem-and-leaf plot, circle graph, or line plot, select the data display that you think will best compare the two girls' practice records. Construct a display to show the data. Compare the amount of time the two girls practice by analyzing the data presented in the display.

8.3.C Create a scatterplot for a two-variable data set, and, when appropriate, sketch and use a trend line to make predictions.

Example:

- Kera randomly selected seventeen students from her middle school for a study comparing arm span to standing height. The students' measurements are shown in the table below.

Comparison of Arm Span and Standing Height (in cm) at Icicle River Middle School

Height (cm)	Arm Span (cm)	Height (cm)	Arm Span (cm)
138	145	155	150
135	135	175	177
142	147	162	160
158	145	150	152
177	174	142	143
150	152	149	149
158	162	160	165
160	160	173	170
160	158		

Create a scatterplot for the data shown.

If appropriate, sketch a trendline.

Use these data to estimate the arm span of a student with a height of 180 cm, and the height of a student with an arm span of 130 cm. Explain any limitations of using this process to make estimates.

Performance Expectations	*Explanatory Comments and Examples*
Students are expected to:	
8.3.D Describe different methods of selecting statistical samples and analyze the strengths and weaknesses of each method.	Students should work with a variety of sampling techniques and should be able to identify strengths and weakness of random, census, convenience, and representative sampling. Example: • Carli, Jamar, and Amberly are conducting a survey to determine their school's favorite Seattle professional sports team. Carli selects her sample using a convenience method—she surveys students on her bus during the ride to school. Jamar uses a computer to randomly select 30 numbers from 1 through 600, and then surveys the corresponding students from a numbered, alphabetical listing of the student body. Amberly waits at the front entrance before school and surveys every twentieth student entering. Analyze the strengths and weaknesses of each method.
8.3.E Determine whether conclusions of statistical studies reported in the media are reasonable.	
8.3.F Determine probabilities for mutually exclusive, dependent, and independent events for small sample spaces.	Examples: • Given a standard deck of 52 playing cards, what is the probability of drawing a king or queen? [Some students may be unfamiliar with playing cards, so alternate examples may be desirable.] • Leyanne is playing a game at a birthday party. Beneath ten paper cups, a total of five pieces of candy are hidden, with one piece hidden beneath each of five cups. Given only three guesses, Leyanne must uncover three pieces of candy to win all the hidden candy. What is the probability she will win all the candy? • A bag contains 7 red marbles, 5 blue marbles, and 8 green marbles. If one marble is drawn at random and put back in the bag, and then a second marble is drawn at random, what is the probability of drawing first a red marble, then a blue marble?

Performance Expectations	Explanatory Comments and Examples
Students are expected to:	
8.3.G Solve single- and multi-step problems using counting techniques and Venn diagrams and verify the solutions.	The intent of this expectation is for students to show their work, explain their thinking, and verify that the answer to the problem is reasonable in terms of the original context and the mathematics used to solve the problem. Verifications can include the use of numbers, words, pictures, or equations. Counting techniques include the fundamental counting principle, lists, tables, tree diagrams, etc. Examples: • Jack's Deli makes sandwiches that include a choice of one type of bread, one type of cheese, and one type of meat. How many different sandwiches could be made given 4 different bread types, 3 different cheeses, and 5 different meats? Explain your reasoning. • A small high school has 57 tenth-graders. Of these students, 28 are taking geometry, 34 are taking biology, and 10 are taking neither geometry nor biology. How many students are taking both geometry and biology? How many students are taking geometry but not biology? How many students are taking biology but not geometry? Draw a Venn diagram to illustrate this situation.