

Data and Probability

Data analysis and probability have become key topics in the elementary school mathematics curriculum. This focus can be attributed to an increased emphasis on understanding how to interpret data in our lives (Reys, Suydam, Lindquist, and Smith, 1999).

The National Council of Teachers of Mathematics (NCTM) sees the need for a strong development of the strand, with concepts and procedures becoming increasingly sophisticated across grades so that by the end of high school, students have a sound knowledge of elementary statistics (NCTM, 2000, p. 47).

The NCTM Data Analysis and Probability Standard (NCTM, 2000, p. 47) makes four recommendations. These recommendations, in conjunction with other current research, form the basis for the Data Analysis and Probability strand in *Houghton Mifflin Math*.

The first NCTM recommendation is to enable all students to **formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them** (NCTM, 2000, p. 48).

Russell and Friel (1989) write that, in order for data collection problems to be meaningful to students, they need to be based on real problems. They define real problems as ones that begin with students either collecting the data themselves or getting the data from real-world sources...there needs to be discussion and debate about what the data means. Also, data that have been collected and organized should be used to generate new questions, not just to obtain “answers.”

Lesson 1 **Collect and Organize Data**
Objective: Collect, organize, and interpret data from a survey.

Work Together

A **survey** is a method of collecting information about a group of people.

Work with a partner to conduct a survey and interpret the results.

1 Make up a survey question like "What is your favorite sport?" or "What is your favorite color?" Write your question on the record sheet.

2 List five or six likely answer choices for the survey question on the record sheet.

3 Ask each of your classmates the survey question.

- Use a tally mark to record each answer.
- Count the tally marks for each answer and write the number in the Frequency column. The frequency of each answer is the number of times it is chosen.

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1 Discuss your results.

- Which choice was the most popular? The least popular?
- Was that choice picked by less than one half, one half, or more than one half of the class?
- Use the information you collected to write a short summary of your survey results.

On Your Own

The table shows the results of a survey of a fifth-grade class. Use the table for Problems 1–4.

- Copy and complete the table.
- How many of those surveyed had 2 brothers and sisters?
- How many students were in the survey?
- Analyze Can you tell how many students surveyed had 5 brothers and sisters? Explain your answer.

Number of Brothers and Sisters	Tally	Frequency
0		
1		
2		
3		
4		
More than 4		

Follow Steps 1–3 on page 192 to survey your classmates about their favorite kinds of music. Then use your results for Problems 5–8.

- Which answer choice was the most popular? Which answer choice was the least popular?
- Did any of your answer choices have the same frequency? Which ones?
- What is the difference in frequency between the most popular choice and the least popular choice?
- Write a short summary of your survey results. Did any of your results surprise you? Explain.

Talk About It • Write About It

You learned how to conduct a survey and interpret the results.

- Look at your results from the activity on pages 192–193. Do you think your results would be different if you surveyed adults? Explain why or why not.
- How might a store owner use a survey to decide what games to sell in the store?

Basile (1999) points out that a teacher plays a crucial role in helping students formulate their questions. Teachers should ask probing questions to allow students to reflect on the research questions to be answered, to sort the important features and record it in tables, to reclassify any seemingly superfluous information, and to best represent results.

Throughout grades K–6 in *Houghton Mifflin Math*, students are given opportunities to formulate questions that are used to collect and represent data. For example, in grade 1, students formulate a question about the shoes their classmates are wearing. They then take a survey, make a graph, and write a conclusion from the graph. By grade 6, students are analyzing questions to be sure they are not biased.

The second NCTM recommendation is to enable all students to **select and use appropriate statistical methods to analyze data** (NCTM, 2000, p. 49).

In lower grades, statistics should be taught informally by examples rather than formulas (Cathcart et al., 2003).

In grade 3 of *Houghton Mifflin Math*, students use a concrete model (snap cubes) to explore range, median, mode, and mean. In grade 4, students learn the formal procedures. By grades 5 and 6, students are analyzing situations to decide which statistic best represents the data.

Name _____

Create and Solve

You are taking a survey about the shoes your classmates are wearing. Write a question for your survey.

Now, take the survey. Make a pictograph.

Write one thing you learned from the pictograph.

Student Book, grade 1, page 93

Lesson 2 Bias

Objective: Identify bias in sampling.

Learn About It!

The city council is going to vote on whether to keep its leash laws. The council is concerned that the samples chosen for the survey may lead to incorrect conclusions. For a survey to lead to correct conclusions, it should avoid bias. Bias can occur in two ways. One way bias can occur is if the sample selected is not representative of the population to be surveyed. Another way bias can occur is if the survey questions are worded in ways meant to lead the people surveyed to give a certain answer.

Sampling the Population		
<p>Sample 1 Surveying dog owners.</p> <ul style="list-style-type: none"> Shows bias since many more dog owners than people with no pets would probably vote yes. 	<p>Sample 2 Surveying people who don't have any pets.</p> <ul style="list-style-type: none"> Shows bias since more people who don't have any pets would probably vote yes. 	<p>Sample 3 Surveying some people who own dogs and some who don't.</p> <ul style="list-style-type: none"> Less likely to show bias since the chances of yes or no responses are equal.

Wording the Survey Question

<p><i>Should the mayor approve a bill requiring dogs that are outdoors to be on leashes at all times, instead of running over people's property?</i></p> <ul style="list-style-type: none"> Shows bias by making it sound like it's a bad idea to "let dogs run over people's property." 	<p><i>Should the mayor approve a bill requiring dogs that are outdoors to be on leashes at all times, instead of running freely in exercise?</i></p> <ul style="list-style-type: none"> Shows bias by making it sound like dogs would benefit by "running freely."
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Solution: Either question would lead to biased results. A better question might be: *Should the mayor approve a bill requiring dogs that are outdoors to be on leashes at all times?*

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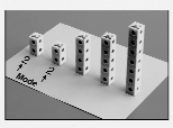
Student Book, grade 6, page 214

STEP 3 Look at the stacks of cubes again. When a set of data is ordered from least to greatest, the middle number is called the **median**.

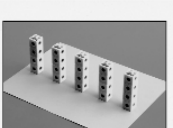
- How many cubes are in the middle stack?
- What is the median of the data?



at the cubes to see if it appears more than once. The number that occurs most often is called the **mode** of the data?



from one stack to the next. The number in the middle stack is called the **mean**.



any cubes are in each stack. The mean of the data?

Student Book, grade 3, page 151

This increased emphasis on statistics also brings recommendations for topics that were not previously taught in elementary schools.

...students will need new tools, including histograms, stem-and-leaf plots, box plots, and scatter plots, to identify similarities and differences among data sets. Students also need tools to investigate association and trends in bivariate data, including scatter plots and fitted lines (NCTM, 2000, p. 49).

By grade 6, students using *Houghton Mifflin Math* will encounter all of the above representations of data.

The third NCTM recommendation is to enable all students to **develop and evaluate inferences and predictions that are based on data** (NCTM, 2000, p. 49).

Results from the sixth National Assessment of Educational Progress (NAEP) further support this recommendation. The majority of fourth-, eighth-, and twelfth-graders tested could read and use data presented in tables. However, students in all these grade levels experienced “difficulty communicating their reasoning about data representation” (Zawojewski and Heckman, 1997, p. 196). These findings indicate that students must be taught more than just how to read tables, graphs, and charts. The goal of instruction should be to teach children to

understand, interpret, and reason logically from data.

Another study by Friel, Curcio, and Bright (2001) yielded similar findings. They note that students usually have an easy time with elementary-level questions (students extract and read information from a graph), but have a tougher time with the read-between-the-data questions (students combine and integrate data and identify the mathematical relationships expressed in the graph), and much harder time with read-beyond-the-data questions (students infer information that is not in the graph).

Throughout the grades, *Houghton Mifflin Math* provides opportunities for students to answer elementary questions, read-between-the-data questions, and read-beyond-the-data questions. For example, on page 383 in grade 4, students are given the daily high temperatures for Monday through Sunday during one week. They construct a graph of the information, use it to find the range, explain what happened to the temperature between Thursday and Sunday, and predict what the high temperature would be for the next Monday.

Practice and Problem Solving

- Use the table at the right to make a line graph. Then use your line graph for Problems 5–7.
- What happened to the temperatures from Thursday through Sunday?
- Predict** Would you expect the high temperature on the day after Sunday to be 20°F, 60°F, or 90°F? Explain your answer.
- What is the range of the temperatures on your graph?

Daily High Temperatures

Day	Temperature
Monday	40°F
Tuesday	45°F
Wednesday	30°F
Thursday	40°F
Friday	35°F
Saturday	30°F
Sunday	25°F

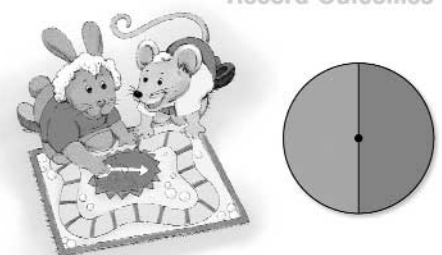
The fourth NCTM recommendation is to enable all students to **understand and apply basic concepts of probability** (NCTM, 2000, p. 50).

Research in children’s learning of probability has often focused on intuitive beliefs about chance. Konold (1991) looks at the possibility of reforming children’s (often incorrect) preconceptions about chance into accurate understanding. He says that for this transition to work, the teacher must understand children’s intuitions, and the children must be encouraged to compare their beliefs with the beliefs of others, with their related beliefs, and with their observations. This suggests that children should make predictions and be asked to communicate reasons for their guesses. They should hear and understand the predictions of other children, and finally observe and record actual trials to test their guesses.




This idea is further substantiated by Cathcart et al. (2003) who emphasize that prediction and experimentation are the key components of probability activities in the primary grades, and Fennell (1990) who emphasizes that classroom activities should be active, involve physical materials, and furnish opportunities for questioning, problem solving, and discussion.

Students using *Houghton Mifflin Math* are given numerous opportunities to predict, talk about their predictions, and conduct trials to test their predictions. In kindergarten, children make predictions about how many times a spinner will land on each color. Then they conduct trials and observe and record the results.

Name _____ **Predict and Record Outcomes** Hands-On



Spin and Tally

Color	Predict	Record
	_____	_____
	_____	_____
	_____	_____

Directions: Predict how many times the spinner will land on each color. If you spin five times, make a tally mark after each spin. Record the number of tally marks. Compare your predictions to the outcomes.

Chapter 5 99

Student Book, grade K, page 99

Throughout the grades they move from using informal language such as “likely” and “unlikely” to calculating both theoretical and experimental probabilities for simple and compound events.

NCTM recommendation . . .
understand and apply
basic concepts of probability.
