THE BIG IDEAS OF STATISTICS
POSING QUESTIONS
Session 1

Topic	Activity Name	Page Number	Related SOL	Activity Sheets	Materials
The Big Ideas of Statistics	Sandwich Problem	2	K.14, K.15, K.16, 1.18, 1.19, 2.23, 2.24, 3.21, 3.22, 3.23, 4.19,4.20, 5.16, 5.17, 5.18, 5.19, 6.18, 6.19, 6.20,7.14, 7.15, 7.16, 7.17, 7.18, 8.11, 8.12, 8.13	Sandwich Problem Narrative, Sandwich Problem Graph	
	Why are Probability and Statistics Important?	5		Readings, Probability and Statistics Strands	Blank transparencies, overhead pens
	The Big Ideas of Statistics	19		2 Graphic Organizer Sheets, SOL Probability and Statistics Strand Grades K-8	
	What are the Goals of the Course?	25		Probability and Statistics Goals	
Posing Questions	Sixth Grade Mystery Data	29	1.19, 2.23, 3.22, 4.20, 5.18, 6.18, 7.18, 8.12	Questions for Sixth Grade Mystery Data, Graphs for Sixth Grade Mystery Data, Graph A, Graph B, Graph C	
	Posing Questions	36	1.19, 2.23, 3.22, 6.18, 7.18, 8.12	Posing Questions	Chart paper, markers, tape

Activity: Sandwich Problem (Warm-Up)

Format: Large Group

Objectives: Participants will develop an appreciation for graphical representations of data and the need for statistics.

Related SOL: All in the Probability and Statistics Strand

Materials: Sandwich Problem Narrative Activity Sheet, and Sandwich Problem Graph Activity Sheet

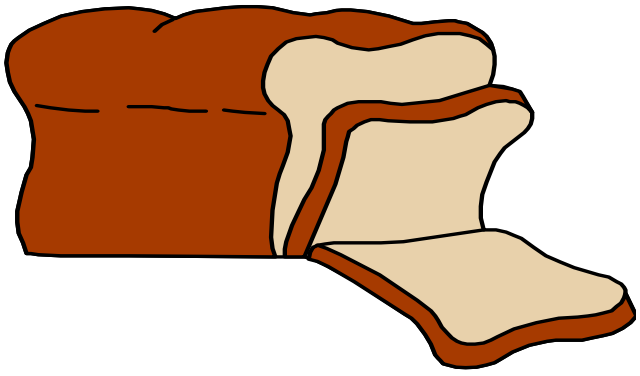
Time Required: 10 minutes

Directions:

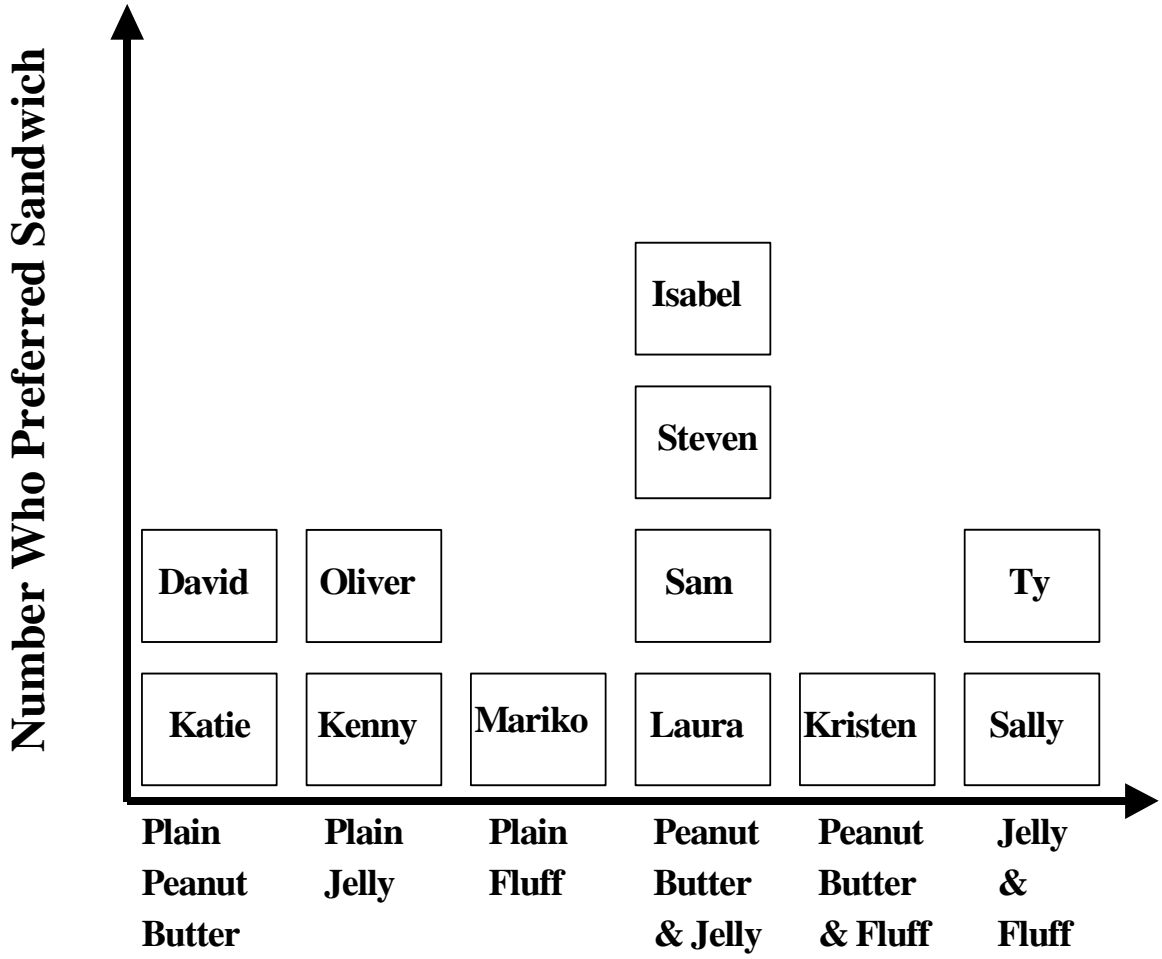
1. Without informing the participants, break them into two groups (front of the audience versus back of the audience).
2. Distribute the two sandwich problem activity sheets FACE DOWN; distribute the graphical representation of the sandwich data to one group; and the narrative version of the data to the other group.
3. Tell the groups that this is a test on the sandwich data and that you are going to keep track of the people who raise their hand first to answer the questions. Then ask them to turn over their papers and respond to the following questions. Keep track of those who answer first, expecting that those with the graphical answer will respond first. Ask the following three questions. Call on the first person who raises a hand to answer the question.
    1. What sandwich was preferred more by people than any other sandwich?
    2. What sandwich types were preferred by only two people?
    3. What sandwich type did Oliver prefer?
4. After reinforcing that one part of the room was doing better than the others in answering the questions, show the entire group a copy of both types of data. This is a good place to begin the discussion of why statistics is important in this “information age” which can be found in Session I Activity 2.
5. Distribute the extra copies of activity sheets so that each participant has a copy of both the graph and narrative sandwich problem activity sheets.

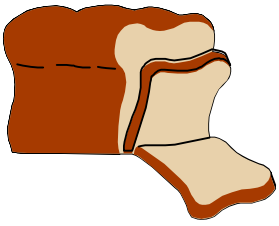
The Lunch Bunch's Favorites

Laura had peanut butter and jelly. Kenny had plain jelly. Oliver also had plain jelly. Katie and David had plain peanut butter. Oh, I forgot to mention that Steven, Isabel, and Sam also had peanut butter and jelly. Kristen had peanut butter and fluff. Mariko had plain fluff while Sally and Ty had jelly and fluff.



The Lunch Bunch's Favorites





Activity: Why are Probability and Statistics Important?

Format: Whole group, Mini-Lecture

Objectives: Participants will understand the rationale for including probability and statistics topics in the K-8 curriculum based on the NCTM Standards.

Related SOL: All in the Probability and Statistics Standards of Learning

Materials: Activity Sheets containing Excerpts 1-5 from the NCTM Principles and Standards for School Mathematics "Why are Probability and Statistics Important in the K-8 Curriculum?"; Strands of Probability and Statistics in the Principles and Standards for School Mathematics (2000); blank transparencies, overhead pens

Time Required: 45 minutes

Directions:

1. Use a modified form of the "Jigsaw" cooperative learning procedure to answer the question "Why are Probability and Statistics Important in the K-8 Curriculum?" Use the NCTM Principles and Standards for School Mathematics excerpts on Probability and Statistics as the resource for this "Jigsaw."
2. In jigsaw, five groups of participants will be responsible for teaching each other the material. The NCTM resource is divided into 5 expert areas. Each group should be assigned one excerpt and each team member should read the material first. At a signal, all participants on a team should get together and elect a leader and a reporter for their team. The leader should facilitate a discussion to identify the important points in their excerpt to answer the question "Why are Probability and Statistics Important in the K-8 Curriculum?" The reporter should record the points mentioned by team members.
3. The instructor should then ask the reporter for each team to report on the team's discussion and record the ideas on a blank overhead transparency. The instructor may wish to summarize the participant's remarks and add any of his or her own before concluding this activity.

NATIONAL COUNCIL OF TEACHERS OF MATHEMATICS Principles and Standards for School Mathematics - Resource for Discussion on "Why are Statistics Important in the K-8 Curriculum?"

EXCERPT 1:

Standard 5: Data Analysis and Probability
Instructional programs from Prekindergarten through grade 12 should enable all students to

- ***Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them;***
- ***Select and use appropriate statistical methods to analyze data;***
- ***Develop and evaluate inferences and predictions that are based on data; and***
- ***Understand and apply basic concepts of probability.***

Elaboration: Pre-K-12

The Data Analysis and Probability Standard recommends that students formulate questions that can be answered using data and addresses what is involved in gathering and using the data wisely. Students should learn how to collect data, organize their own or others' data, and display the data in graphs and charts that will be useful in answering their questions. This Standard also includes learning some methods for analyzing data and some ways of making inferences and conclusions from data. The basic concepts and applications of probability are also addressed, with an emphasis on the way that probability and statistics are related.

The amount of data available to help make decisions in business, politics, research, and everyday life is staggering: Consumer surveys guide the development and marketing of products. Polls help determine political-campaign strategies, and experiments are used to evaluate the safety and efficacy of new medical treatments. Statistics are often misused to sway public opinion on issues or to misrepresent the quality and effectiveness of commercial products. Students need to know about data analysis and related aspects of probability in order to reason statistically—skills necessary to becoming informed citizens and intelligent consumers.

The increased curricular emphasis on data analysis proposed in these Standards is intended to span the grades rather than to be reserved for the middle grades and secondary school, as is common in many countries. NCTM's 1989 *Curriculum and Evaluation Standards for School Mathematics* introduced standards in statistics and probability at all grade bands; a number of organizations have developed instructional materials and professional

development programs to promote the teaching and learning of these topics. Building on this base, these Standards recommend a strong development of the strand, with concepts and procedures becoming increasingly sophisticated across the grades so that by the end of high school students have a sound knowledge of elementary statistics. To understand the fundamentals of statistical ideas, students must work directly with data. The emphasis on working with data entails students' meeting new ideas and procedures as they progress through the grades rather than revisiting the same activities and topics. The data and statistics strand allows teachers and students to make a number of important connections among ideas and procedures from number, algebra, measurement, and geometry. Work in data analysis and probability offers a natural way for students to connect mathematics with other school subjects and with experiences in their daily lives.

In addition, the processes used in reasoning about data and statistics will serve students well in work and in life. Some things children learn in school seem to them predetermined and rule bound. In studying data and statistics, they can also learn that solutions to some problems depend on assumptions and have some degree of uncertainty. The kind of reasoning used in probability and statistics is not always intuitive, and so students will not necessarily develop it if it is not included in the curriculum.

NATIONAL COUNCIL OF TEACHERS OF MATHEMATICS Principles and Standards for School Mathematics - Resource for Discussion on "Why is Statistics Important in the K-8 Curriculum?"

EXCERPT 2:

Standard 5: Data Analysis and Probability
Instructional programs from Prekindergarten through grade 12 should enable all students to

- ***Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them;***
- ***Select and use appropriate statistical methods to analyze data;***
- ***Develop and evaluate inferences and predictions that are based on data; and***
- ***Understand and apply basic concepts of probability.***

Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them.

Because young children are naturally curious about their world, they often raise questions such as, How many? How much? What kind? or Which of these? Such questions often offer opportunities for beginning the study of data analysis and probability. Young children like to design questions about things close to their experience—What kind of pets do classmates have? What are children's favorite kinds of pizza? As students move to higher grades, the questions they generate for investigation can be based on current issues and interests. Students in grades 6–8, for example, may be interested in recycling, conservation, or manufacturers' claims. They may pose questions such as, Is it better to use paper or plastic plates in the cafeteria? or Which brand of batteries lasts longer? By grades 9–12, students will be ready to pose and investigate problems that explore complex issues.

Young children can devise simple data-gathering plans to attempt to answer their questions. In the primary grades, the teacher might help frame the question or provide a tally sheet, class roster, or chart on which data can be recorded as they are collected. The "data" might be real objects, such as children's shoes arranged in a bar graph or the children themselves arranged by interest areas. As students move through the elementary grades, they should spend more time planning the data collection and evaluating how well their methods worked in getting information about their questions. In the middle grades, students should work more with data that have been gathered by others or generated by simulations. By grades 9–12, students should understand the various purposes of surveys, observational studies, and experiments.

A fundamental idea in prekindergarten through grade 2 is that data can be organized or ordered and that this "picture" of the data provides information about the phenomenon or question. In grades 3–5, students should develop skill in representing their data, often using bar graphs, tables, or line plots. They should learn what different numbers, symbols, and points mean. Recognizing that some numbers represent the values of the data and others represent the frequency with which those values occur is a big step. As students begin to understand ways of representing data, they will be ready to compare two or more data sets. Books, newspapers, the World Wide Web, and other media are full of displays of data, and by the upper elementary grades, students ought to learn to read and understand these displays. Students in grades 6–8 should begin to compare the effectiveness of various types of displays in organizing the data for further analysis or in presenting the data clearly to an audience. As students deal with larger or more-complex data sets, they can reorder data and represent data in graphs quickly, using technology so that they can focus on analyzing the data and understanding what they mean.

NATIONAL COUNCIL OF TEACHERS OF MATHEMATICS Principles and Standards for School Mathematics - Resource for Discussion on "Why is Statistics Important in the K-8 Curriculum?"

EXCERPT 3:

Standard 5: Data Analysis and Probability
Instructional programs from Prekindergarten through grade 12 should enable all students to

- ***Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them;***
- ***Select and use appropriate statistical methods to analyze data;***
- ***Develop and evaluate inferences and predictions that are based on data; and***
- ***Understand and apply basic concepts of probability.***

Select and use appropriate statistical methods to analyze data.

Although young children are often most interested in their own piece of data on a graph (I have five people in my family), putting all the students' information in one place draws attention to the set of data. Later, students should begin to describe the set of data as a whole. Although this transition is difficult (Konold forthcoming), students may, for example, note that "more students come to school by bus than by all the other ways combined." By grades 3–5, students should be developing an understanding of aggregated data. As older students begin to see a set of data as a whole, they need tools to describe this set. Statistics such as measures of center or location (e.g., mean, median, mode), measures of spread or dispersion (range, standard deviation), and attributes of the shape of the data become useful to students as descriptors. In the elementary grades, students' understandings can be grounded in informal ideas, such as middle, concentration, or balance point (Mokros and Russell 1995). With increasing sophistication in secondary school, students should choose particular summary statistics according to the questions to be answered.

Throughout the school years, students should learn what it means to make valid statistical comparisons. In the elementary grades, students might say that one group has more or less of some attribute than another. By the middle grades, students should be quantifying these differences by comparing specific statistics. Beginning in grades 3–5 and continuing in the middle grades, the emphasis should shift from analyzing and describing one set of data to comparing two or more sets (Konold forthcoming). As they move through the middle grades into high school, students will need new tools, including histograms, stem-and-leaf plots, box plots, and scatterplots, to identify similarities and differences among data sets. Students also need tools to investigate association and bivariate

data, including scatterplots and fitted lines in grades 6–8 and residuals and correlation in grades 9–12.

NATIONAL COUNCIL OF TEACHERS OF MATHEMATICS Principles and Standards for School Mathematics - Resource for Discussion on "Why is Statistics Important in the K-8 Curriculum?"

EXCERPT 4:

Standard 5: Data Analysis and Probability
Instructional programs from Prekindergarten through grade 12 should enable all students to

- ***Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them;***
- ***Select and use appropriate statistical methods to analyze data;***
- ***Develop and evaluate inferences and predictions that are based on data; and***
- ***Understand and apply basic concepts of probability.***

Develop and evaluate inferences and predictions that are based on data

Central elements of statistical analysis—defining an appropriate sample, collecting data from that sample, describing the sample, and making reasonable inferences relating the sample and the population—should be understood as students move through the grades. In the early grades, students are most often working with census data, such as a survey of each child in the class about favorite kinds of ice cream. The notion that the class can be viewed as a sample from a larger population is not obvious at these grades. Upper elementary and early middle-grades students can begin to develop notions about statistical inference, but developing a deep understanding of the idea of sampling is difficult (Schwartz et al. 1998). Research has shown that students in grades 5–8 expect their own judgment to be more reliable than information obtained from data (Hancock, Kaput, and Goldsmith 1992). In the later middle grades and high school, students should address the ideas of sample selection and statistical inference and begin to understand that there are ways of quantifying how certain one can be about statistical results.

In addition, students in grades 9–12 should use simulations to learn about sampling distributions and make informal inferences. In particular, they should know that basic statistical techniques are used to monitor quality in the workplace. Students should leave secondary school » with the ability to judge the validity of arguments that are based on data, such as those that appear in the press.

NATIONAL COUNCIL OF TEACHERS OF MATHEMATICS Principles and Standards for School Mathematics - Resource for Discussion on "Why is Statistics Important in the K-8 Curriculum?"

EXCERPT 5:

Standard 5: Data Analysis and Probability
Instructional programs from Prekindergarten through grade 12 should enable all students to

- ***Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them;***
- ***Select and use appropriate statistical methods to analyze data;***
- ***Develop and evaluate inferences and predictions that are based on data; and***
- ***Understand and apply basic concepts of probability.***

Understand and apply basic concepts of probability

A subject in its own right, probability is connected to other areas of mathematics, especially number and geometry. Ideas from probability serve as a foundation to the collection, description, and interpretation of data.

In prekindergarten through grade 2, the treatment of probability ideas should be informal. Teachers should build on children's developing vocabulary to introduce and highlight probability notions, for example, We'll *probably* have recess this afternoon, or It's *unlikely* to rain today. Young children can begin building an understanding of chance and randomness by doing experiments with concrete objects, such as choosing colored chips from a bag. In grades 3–5 students can consider ideas of chance through experiments—using coins, dice, or spinners—with known theoretical outcomes or through designating familiar events as impossible, unlikely, likely, or certain. Middle-grades students should learn and use appropriate terminology and should be able to compute probabilities for simple compound events, such as the number of expected occurrences of two heads when two coins are tossed 100 times. In high school, students should compute probabilities of compound events and understand conditional and independent events. Through the grades, students should be able to move from situations for which the probability of an event can readily be determined to situations in which sampling and simulations help them quantify the likelihood of an uncertain outcome.

Many of the phenomena that students encounter, especially in school, have predictable outcomes. When a fair coin is flipped, it is equally likely to come up heads or tails. Which outcome will result on a given flip is uncertain—even if ten flips in a row have resulted in heads, for many people it is counterintuitive that

the eleventh flip has only a 50 percent likelihood of being tails. If an event is random and if it is repeated many, many times, then the distribution of outcomes forms a pattern. The idea that individual events are not predictable in such a situation but that a pattern of outcomes can be predicted is an important concept that serves as a foundation for the study of inferential statistics.

NCTM Principles and Standards for School Mathematics Probability and Statistics Strands

NCTM Focus Areas K - 2 In grades pre-K-2, all students should-	**NCTM Focus Areas 3-5** In grades 3-5, all students should-	**NCTM Focus Areas 6-8** In grades 6-8, all students should-
Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them • pose questions and gather data about themselves and their surroundings; • sort and classify objects according to their attributes and organize data about the objects; • represent data using concrete objects, pictures, and graphs.	**Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them** • design investigations to address a question and consider how data-collection methods affect the nature of the data set; • collect data using observations, surveys, and experiments; • represent data using tables and graphs such as line plots, bar graphs, and line graphs; • recognize the differences in representing categorical and numerical data.	**Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them** • formulate questions, design studies, and collect data about a characteristic shared by two populations or different characteristics within one population; • select, create, and use appropriate graphical representations of data, including histograms, box plots, and scatterplots.

NCTM Principles and Standards for School Mathematics Probability and Statistics Strands

NCTM Focus Areas K – 2 In grades pre-K-2, all students should-	**NCTM Focus Areas 3-5** In grades 3-5, all students should-	**NCTM Focus Areas 6-8** In grades 6-8, all students should-
Select and use appropriate statistical methods to analyze data • describe parts of the data and the set of data as a whole to determine what the data show.	**Select and use appropriate statistical methods to analyze data** • describe the shape and important features of a set of data and compare related data sets, with an emphasis on how the data are distributed; • use measures of center, focusing on the median, and understand what each does and does not indicate about the data set; • compare different representations of the same data and evaluate how well each representation shows important aspects of the data.	**Select and use appropriate statistical methods to analyze data** • find, use, and interpret measures of center and spread, including mean and interquartile range; • discuss and understand the correspondence between data sets and their graphical representations, especially histograms, stem-and-leaf plots, box plots, and scatterplots.

NCTM Principles and Standards for School Mathematics Probability and Statistics Strands

NCTM Focus Areas PreK - 2 In grades pre-K-2, all students should-	**NCTM Focus Areas 3-5** In grades 3 - 5, all students should-	**NCTM Focus Areas 6-8** In grades 6 - 8, all students should-
Develop and evaluate inferences and predictions that are based on data • discuss events related to students' experiences as likely or unlikely.	**Develop and evaluate inferences and predictions that are based on data** • propose and justify conclusions and predictions that are based on data and design studies to further investigate the conclusions or predictions.	**Develop and evaluate inferences and predictions that are based on data** • use observations about differences between two or more samples to make conjectures about the populations from which the samples were taken; • make conjectures about possible relationships between two characteristics of a sample on the basis of scatterplots of the data and approximate lines of fit; • use conjectures to formulate new questions and plan new studies to answer them.

NCTM Principles and Standards for School Mathematics Probability and Statistics Strands

NCTM Focus Areas 3-5 In grades 3-5, all students should-	**NCTM Focus Areas 6-8** In grades 6-8, all students should-
Understand and apply basic concepts of probability • describe events as likely or unlikely and discuss the degree of likelihood using such words as certain, equally likely, and impossible; • predict the probability of outcomes of simple experiments and test the predictions; • understand that the measure of the likelihood of an event can be represented by a number from 0 to 1.	**Understand and apply basic concepts of probability** • understand and use appropriate terminology to describe complementary and mutually exclusive events; • use proportionality and a basic understanding of probability to make and test conjectures about the results of experiments and simulations; • compute probabilities for simple compound events, using such methods as organized lists, tree diagrams, and area models.

Activity: The Big Ideas of Statistics

Format: Small Group

Objectives: Participants will discuss the meaning of statistics and identify the big ideas that constitute statistics in the K-8 Standards of Learning.

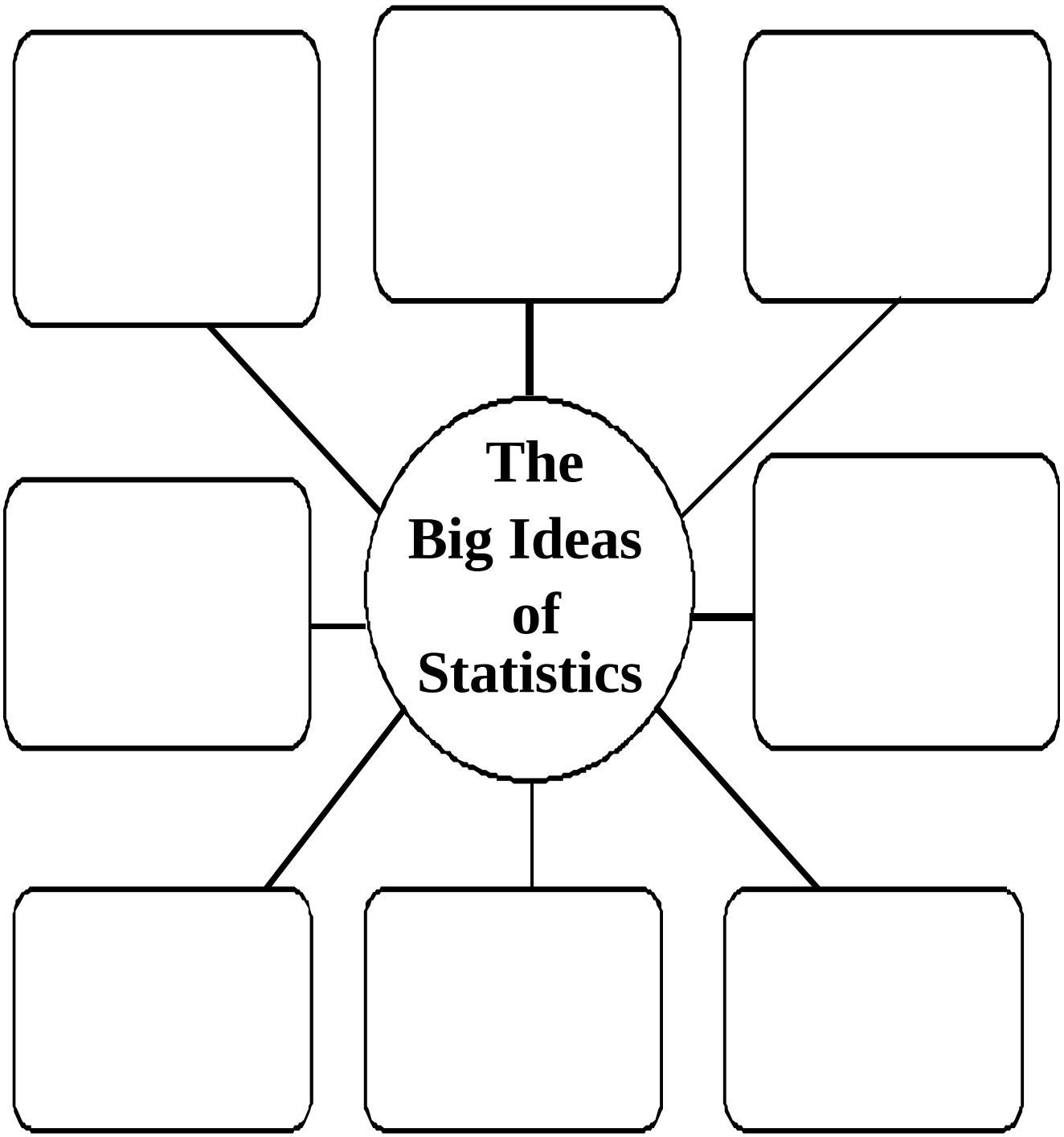
Related SOL: All in the Probability and Statistics Standards of Learning

Materials: Graphic Organizer Sheet "The Big Ideas of Statistics", grade level copies of the Standards of Learning for Probability and Statistics, The Process of Statistical Investigation Graphic Organizer Sheet

Time Required: 15 minutes

Directions:

1. Organize participants into small groups of 4 (preferably with different grade levels represented). Each group receives one copy of the graphic organizer sheet, The Big Ideas of Statistics.
2. Pose the question: What are the "Big Ideas" or the Key Concepts that should be taught in grades K-5 (or Grades 6-8 depending upon your audience) Probability and Statistics? Have participants refer to the Standards of Learning to look for key words and ideas. Have a group recorder write the words they associate with statistics into the graphic organizer. Give groups about 5 minutes to discuss.
3. Have groups contribute ideas in a large group discussion. Record ideas in a webbing fashion to show how ideas connect on The Big Ideas of Statistics. Discuss each briefly and give examples. The big ideas include: pose a problem, collect data, organize data, represent the data graphically, analyze the data, and interpret the data.
4. Discuss the process of statistical investigation and show The Process of Statistical Investigation Graphic Organizer Sheet.


The
Big Ideas
of
Statistics

Virginia Standards of Learning

Probability and Statistics Strand
Grades K - 5

K.14 The student will gather data relating to familiar experiences by counting and tallying.

K.15 The student will display objects and information, using objects, graphs, pictorial graphs, and tables.

K.16 The student will investigate and describe the results of dropping a two-colored counter or using a multicolored spinner.

1.18 The student will investigate, identify, and describe various forms of data collection in his/her world (e.g., recording daily temperature, lunch count, attendance, and favorite ice cream), using tables, picture graphs, and object graphs.

1.19 The student will interpret information displayed in a picture or object graph using the vocabulary: more, less, fewer, greater than, less than, and equal to.

2.23 The student will read, construct, and interpret a simple picture and bar graph.

2.24 The student will record data from experiments using spinners and colored tiles/cubes and use the data to predict which of two events is more likely to occur if the experiment is repeated.

3.21 The student, given grid paper, will a) collect and organize data on a given topic of his/her choice, using observations, measurements, surveys, or experiments; and b) construct a line plot, a picture graph, a bar graph to represent the results. Each graph will include an appropriate title and key.

3.22 The student will read and interpret data represented in line plots, bar graphs, and picture graphs and write a sentence analyzing the data.

3.23 The student will investigate and describe the concept of probability as chance, and list possible results of a given situation.

4.19 The student will a) predict the likelihood of outcomes of a simple event, using the terms certain, likely, unlikely, impossible; and b) determine the probability of a given simple event, using concrete materials.

4.20 The student will collect, organize, and display data in line and bar graphs with scale increments of one or greater than one and use the display to interpret the results, draw conclusions, and make predictions.

5.17 The student will a) solve problems involving the probability of a single event by using tree diagrams or by constructing a sample space representing all possible results; b) predict the probability of outcomes of simple experiments, representing it with fractions or decimals from 0 to 1, and test the prediction; and c) create a problem statement involving probability based on information from a given problem situation. Students will not be required to solve the created problem statement.

5.18 The student will, given a problem situation, collect, organize, and display a set of numerical data in a variety of forms, using bar graphs, stem-and-leaf plots, and line graphs, to draw conclusions and make predictions.

5.19 The student will find the mean, median, mode, and range of a set of data.

Probability and Statistics Strand
Grades 6 - 8

6.18 The student, given a problem situation, will collect, analyze, display, and interpret data in a variety of graphical methods, including a) line, bar, and circle graphs; b) stem-and-leaf plots; and c) box-and-whisker plots. Circle graphs will be limited to halves, fourths, and eighths.

6.19 The student will describe the mean, median, and mode as measures of central tendency, describe the range, and determine their meaning for a set of data.

6.20 The student will a) make a sample space for selected experiments and represent it in the form of a list, chart, picture, or tree diagram; and b) determine and interpret the probability of an event occurring from a given sample space and represent the probability as a ratio, decimal, or percent, as appropriate for the given situation.

7.14 The student will investigate and describe the difference between the probability of an event found through simulation versus the theoretical probability of that same event.

7.15 The student will identify and describe the number of possible arrangements of several objects, using a tree diagram or the Fundamental (Basic) Counting Principle.

7.16 The student will create and solve problems involving the measures of central tendency (mean, median, mode) and the range of a set of data.

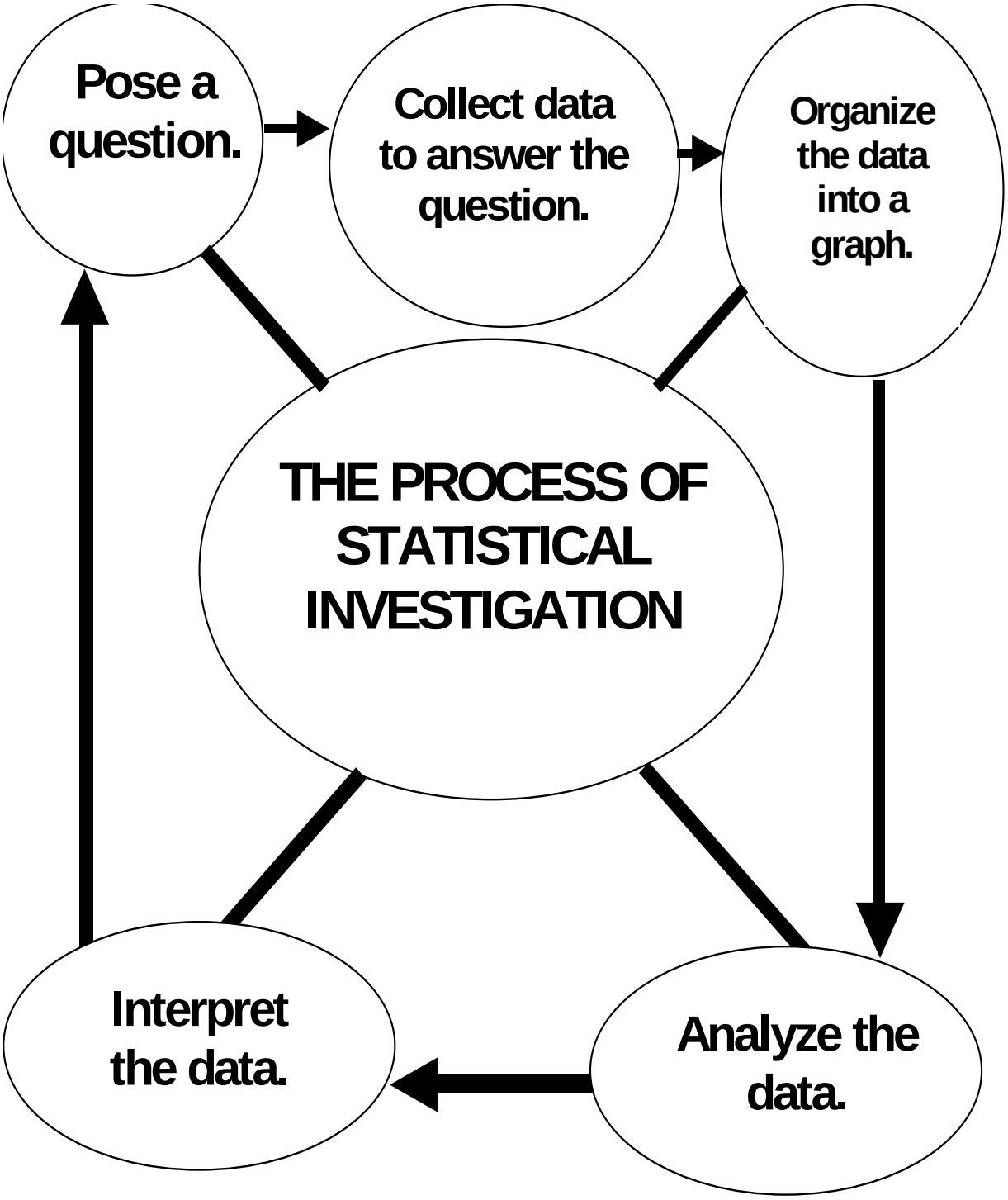
7.17 The student, given a problem situation, will collect, analyze, display, and interpret data, using a variety of graphical methods, including a) frequency distributions; b) line plots; c) histograms; d) stem-and-leaf plots; e) box-and-whisker plots; and f) scattergrams.

7.18 The student will make inferences, conjectures, and predictions based on analysis of a set of data.

8.11 The student will analyze problem situations, including games of chance, board games, or grading scales, and make predictions, using knowledge of probability.

8.12 The student will make comparisons, predictions, and inferences, using information displayed in frequency distributions; box-and-whisker plots; scattergrams; line, bar, circle, and picture graphs; and histograms.

8.13 The student will use a matrix to organize and describe data.


Pose a question.
Collect data to answer the question.
Organize the data into a graph.
THE PROCESS OF STATISTICAL INVESTIGATION
Interpret the data.
Analyze the data.

Activity: What Are the Goals of the Course?

Format: Whole group, Mini-Lecture

Objectives: Participants will review the goals of the institute and discuss their present use of probability and statistics in their classroom.

Related SOL: Probability and Statistics Standards of Learning

Materials: Probability and Statistics Goals Activity Sheet

Time Required: 15 minutes

Directions:

1. Review each of the goals indicated in the goals of the course statement.
2. Ask questions to find out what teachers are presently doing in their teaching of probability and statistics to glean a sense of their knowledge and use of the forthcoming content.

PROBABILITY AND STATISTICS GOALS

The teacher will:

1. Formulate a question and understand its relationship to the problem under study and the variables that will be used for the statistical investigation.

2. Sort and classify objects according to similar attributes to identify "variables" (i.e., categories, independent variable, etc.) contained within a set of data.

3. Demonstrate various techniques to collect data including:
   - surveys
   - observations
   - questionnaires
   - polls
   - interviews
   - examining past records
   - experimentation using instruments
   - simulations.

4. Use tabulations such as tallies, counters, and counting to record the collected data.

5. Demonstrate various techniques to organize data including:
   - pictures
   - lists
   - charts
   - tables
   - tree diagrams
   - matrices
   - stem-and-leaf plots
   - ordered pairs.

6. Determine the most effective graphical method to display a given set of data.

7. Display data using graphical representations including:
   - object graphs
   - bar graphs
   - circle graphs
   - picture graphs
   - line graphs
   - line plots

- frequency distributions
- box-and-whisker plots
- stem-and-leaf plots
- the coordinate plane
- scattergrams
- histograms.

8. Determine and interpret the measures of central tendency and the range.

9. Analyze the data and interpret the results of an investigation. Consider the elements such as:
   - common features
   - unique features
   - similarities and differences
   - the relationships between the variables
   - cause and effect
   - generalizations
   - predictions
   - averaging.

10. Address the following questions:
    - What do the results mean?
    - What does the graph show?
    - What would happen “if”?
    - What do you expect?
    - Is there a change?
    - Is there a relationship?
    - Is there a pattern?
    - What conclusions can you draw?
    - How do your results compare to your predictions?

11. Investigate and determine the probability of a given simple event by representing all possible results of the given event using:
    - concrete materials
    - lists
    - charts
    - tables
    - tree diagrams
    - constructing a sample space
    - the Fundamental (Basic) Counting Principle.

12. Express the probability of a given simple event in an appropriate form, including:
    - ratios
    - decimals
    - percents.

13. Analyze and interpret the results of a probability problem including:
    - predicting which of two events is more likely
    - investigating the differences between the probability of an event found through simulation (experimental probability) versus theoretical probability
    - determining whether the experiment is fair.

Activity: Sixth Grade Mystery Data

Format: Small Groups; Whole Group

Objectives: Participants will develop an understanding of the relationship between the question and the analysis of the data.

Related SOL: 1.19, 2.23, 3.22, 4.20, 5.18, 6.18, 7.18, 8.12

Materials: Copies of Sixth Grade Mystery Data, Copies of Questions, Copies of Graphs A, B, and C

Time Required: 30 minutes

Directions:

1. Divide the participants into small groups of four to five. Give each group a copy of the Sixth Grade Mystery Data and a copy of the questions to be answered. Tell them they have 15 minutes to answer the questions and to discuss their solutions.

2. After the small groups have completed the task, have the entire group share their solutions and how they arrived at those solutions. Focus the discussion on the relationship of the question to the data.

3. Discuss Graph A (Ice Cream Preferences). Have participants share questions about this graph that could be asked of K-2 students.

4. Discuss Graph B (Number of Cavities). Have participants share questions about this graph that could be asked of students in grades 3-5.

5. Discuss Graph C (Relationship of Height to Age). Have participants share questions about this graph that could be asked of students in grades 6-8.

Sixth Grade Mystery Data

Look at the graphs on the next pages. Each graph shows something about a classroom of sixth graders.

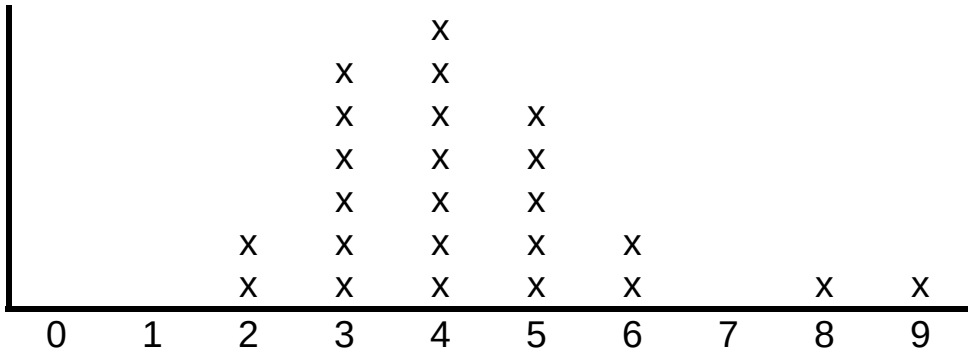
1. **Which of the five graphs do you think shows:**
   a. **The number of cavities the sixth graders have?**
   b. **The number of people in the sixth graders' families?**
   c. **The ages of the sixth graders' mothers?**
   d. **The heights of the sixth graders in inches?**

2. **Why do you think the graph you picked for d is the one that shows the heights of sixth graders? Why do you think the other graphs don't show the sixth graders' heights?**

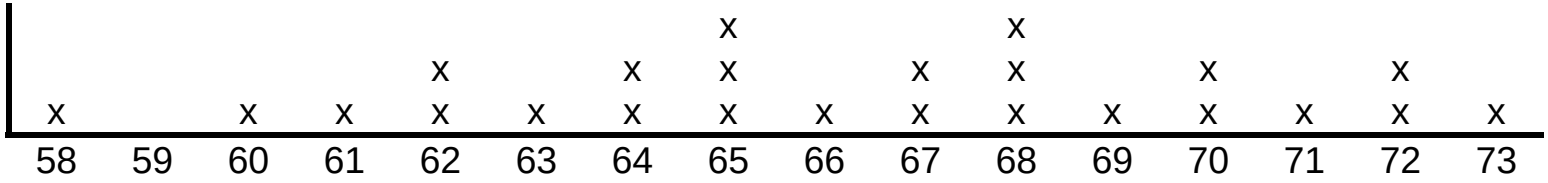
3. **One of the graphs was not selected to answer question one above. What do you think this data display might represent? Why?**

Sixth Grade Mystery Data

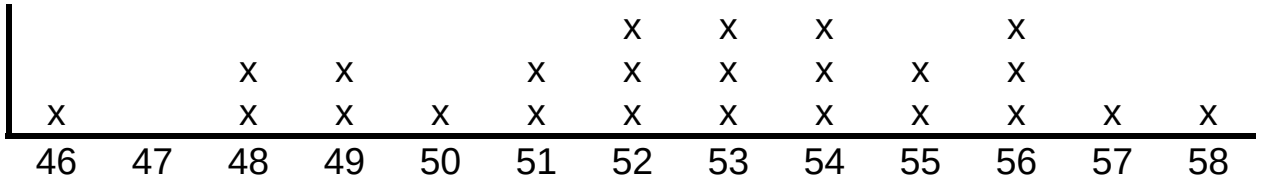
Graph 1



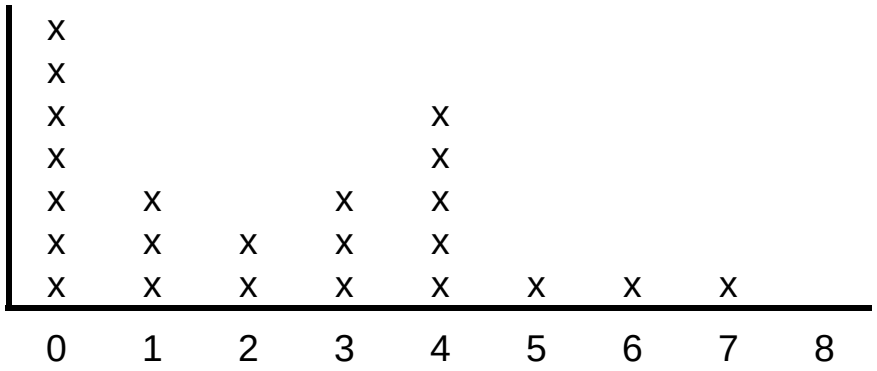
Graph 2



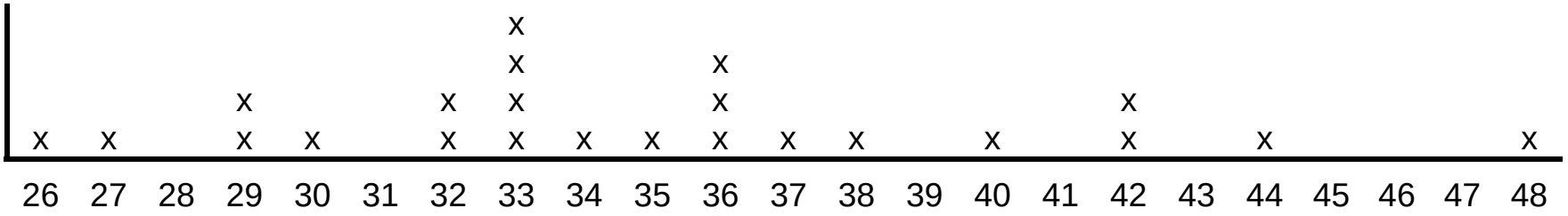
Graph 3



Graph 4



Graph 5



Graph A

Ice Cream Preferences

Vanilla 

Chocolate 

Mint Chip 

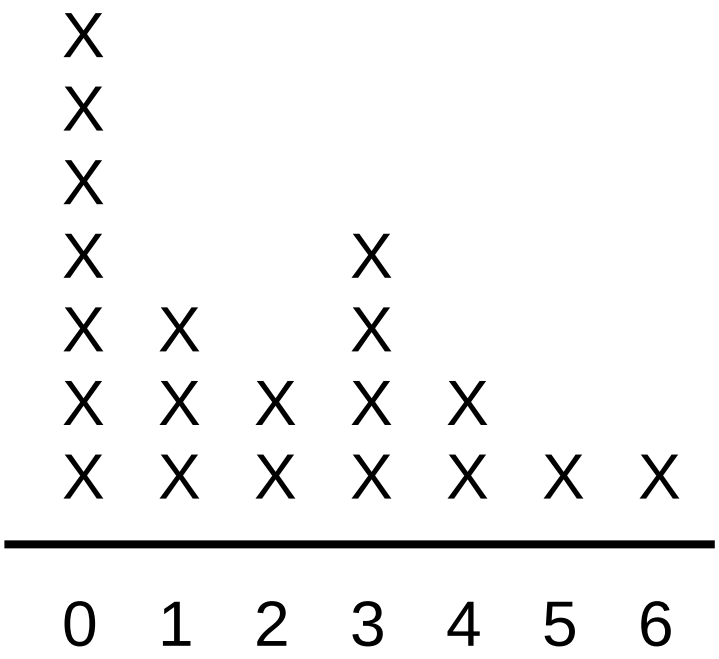
Cookies & Cream 

Other 

 = 1 student

Graph B

Number of Cavities



Graph C

Relationship of Height to Age

Activity: Posing Questions

Format: Small Group; Large Group

Objectives: Participants will construct a variety of grade-appropriate question stems that focus on ideas such as generalizing, comparing and contrasting, summarizing, describing, interpreting, and predicting.

Related SOL: 1.19, 2.23, 3.22, 4.20, 5.18, 6.18, 7.18, 8.12

Materials: Chart paper and markers, tape, Posing Questions Activity Sheet, Examples of Questions Activity Sheet

Time Required: 40 minutes

Directions:

1. Remind participants that, in the last activity, they looked at questions that helped focus on mystery data. Explain that, in this activity, the focus will be on designing questions to help students look beyond just "reading" a graph. Discuss the terms on the Posing Questions Activity Sheet. Have the whole group discuss the meanings of, and the differences between, the terms displayed. Be certain that the discussion includes the following:
   - *Generalizing* is finding the general or over-all character of a set of data, as opposed to specific characteristics, so that broad inferences can be made.
   - *Comparing and contrasting* is the discussion of the characteristics the data (or graphs) have in common as well as the differences.
   - *Describing data* means looking at the shape or trends in the data display.
   - *Interpreting the data* means looking at what is displayed in relationship to the question posed.
   - *Summarizing data* means looking at the main points seen in the data display and is a concise explanation of the results.
   - *Predicting* is the act of using the data to predict the results of additional sampling or extending the conclusions beyond the original sample to a larger group.

2. Divide the participants into grade-level groups (K, 1, 2, 3…). If the entire group is small or a particular grade level is underrepresented, it may be necessary to group participants (e.g., K-1, 2-3, 4-5, and 6-8). Give each group several sheets of chart paper and some markers.

3. Ask each small group to review the SOL for their grade level to review the types of data displays that are appropriate. Have them think about the kinds

of questions students might use to collect data and how those displays might look.

4. Have the small groups generate grade-appropriate question stems that could be used by students to collect data. Share examples (use Activity Sheet with Examples) such as the following. A first grader might complete the stem, "What is your favorite _____?" to collect data to construct a picture or object graph. Older students might use the stems "Has there been a change over time?" or "Is there a relationship between _____and _____?" Have each group label the chart paper with the appropriate grade level, write their question stems on the chart paper, and post them on the wall.

5. Have participants do a museum walk. Each group moves around the room and reviews the grade-appropriate question stems of the other groups. The focus of the tour is to study the question stems generated for each grade level looking for common threads, and progression in the level of complexity through the grade levels.

6. Tell the participants that this topic will be revisited as they complete other sessions. Question stems that can be used to generate the specific type of graph being studied will be added to their lists.

7. Reconvene the large group and have participants share what they learned about forming question stems at different grade levels.

Posing questions that focus on data and cause students to:

- generalize
- compare and contrast
- describe
- interpret
- summarize
- predict

Examples To Get You Started
Posing questions that focus on data and cause students to:

- generalize

  How many M&M's could you expect to find in a fun-size bag of M&M's?

  How many Blue M&M's could you expect to find in a fun-size bag of M&M's?

- compare and contrast

  What are the differences in rainfall between the city that you live in and the city you most want to visit?

- describe

  How many hours of TV are watched by the typical student in the classroom?

  How long can the typical fifth grader hold their breath?

- summarize

  What is the typical foot length (to the nearest quarter inch) of students in a given grade (or in each of the grades from kindergarten through fifth grade)?

- predict

  What would you predict to be the differences in height (in inches) between the shortest and tallest within any classroom in the school?