SSMILes

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Chocolate Chip Cookies: A Consumer Unit Part I: Using Statistics

Grade Level: 4-6

Mathematics Concepts/Skills

Data collection, display, and analysis; introduction to descriptive statistics; computation and use of calculators; price comparisons.

Science Concepts/Processes

Problem solving, comparing, classifying, inferring, hypothesizing, consumer awareness.

Objectives:

1. Students will learn to organize and display data.
2. Students will understand the basic concepts of descriptive statistics and be able to calculate range, mean, median, and mode.
3. Students will understand some of the variables involved with being wise consumers (price, taste).

Rationale

The lessons described in this unit use chocolate chip cookies to involve children in scientific investigation and mathematical reasoning. When students work with real situations and meaningful data, they see problem solving and computation in the context of their everyday lives. They see that mathematics is the language of science and that quantitative data can be useful in decision-making. The *Curriculum and Evaluation Standards for School Mathematics* emphasize that students should collect and analyze data about real-world problems and interpret and communicate the results of their investigations (National Council of Teachers of Mathematics, 1989). The proposed *National Science Education Standards* also recommends that students become competent in using the methods of reasoning of scientific inquiry (National Research Council, 1994).

Children in the upper elementary grades are generally at a stage in their cognitive development where they can apply logic to concrete situations (Berk, 1993). However, they may have little experience in thinking through the steps of collecting data, organizing it, analyzing it systematically, and drawing logical conclusions from it. When children do this type of work, they practice computational skills, but even more important, they must try to figure out exactly what questions the data answer. In the unit described here, children count and graph the number of chips in several types of cookies, but their data will not tell them what the best cookies are. Other variables may be more important than number of chips.

Through their study of cookies, children are introduced to basic statistical procedures. When children analyze data they have collected, statistical terms become meaningful to them; they will understand these terms when encountered later in a textbook, report, or newspaper article. The *Standards* indicate that "a knowledge of statistics is necessary if students are to become intelligent consumers who can make critical and informed decisions" (NCTM, 1989, p. 105).

In this unit, students explore consumer issues when they consider the variables of chocolate chip cookies. They collect price data from a variety of sources and design a logical system for sampling and organizing their data. They may do taste-testing as they consider what makes a chocolate chip cookie good and how quality and price interact.

Background Information

Statistics are a tool which can be used to help answer questions; they provide systematic procedures for summarizing, describing, and evaluating information (NCTM, 1989). However, statistics can be misleading; they can be based on faulty data or can be presented in such a way as to distort the truth (Hayslett, 1968). Children can learn to evaluate statistical information by asking questions about the study's data collection techniques and the appropriateness of the

data display format; the picture book *Statistics* (Srivastava, 1973) gives examples of questions to ask.

Statistics are most meaningful to children when the information is relevant to their daily lives and when they have gathered the data and calculated the statistics themselves. According to the *Standards*, "students need to be actively involved in each of the steps that comprise statistics, from gathering information to communicating results" (NCTM, 1989, p. 105).

In order to be usable, data must be arranged and/or classified. Scores can be arrayed from lowest to highest or put into a frequency distribution, which may be represented by a table, bar graph, or pictograph (Evered, 1994). Line graphs can be used to show change over time, and circle graphs can show proportions of a whole. Students can use computer database programs to organize and display information, creating a number of types of graphs and plots (NCTM, 1989).

This article focuses on descriptive statistics, which are used to summarize data in two ways. Measures of central tendency indicate the average or most typical score, and measures of variation indicate the spread among the scores (Hinkle, Wiersma, & Jurs, 1988). Students should learn when and why to use each type of statistic; simply knowing how to do the calculations is not enough.

Measures of central tendency include three types of averages: mode, median, and mean. (Please note that although many people use the term "average" to indicate the arithmetic mean, in this article it is used to indicate all three measures of central tendency.) Each of these statistics has advantages and disadvantages; the average which best fits the situation should be used.

The mode is the score or value which occurs most frequently; a data set may have more than one mode. The mode is especially good for nonnumerical data, for example, to answer the question "What color pants were worn today?" (NCTM, 1989). With numerical data, the mode is good to use if the frequency distribution is rather symmetrical; otherwise, the mode will not coincide with the center of the data as calculated by other methods (Hayslett, 1968).

The median can be calculated by arranging the scores or observations in order from smallest to largest and counting to find the middle observation if the number of scores is odd or the halfway point between the two middle scores if the number of scores is even. The median is easy to find if the data are arranged in order. Another advantage of the median is that it is not too affected by extreme or outlying data.

The mean is probably the most frequently used measure of central tendency, especially in inferential statistics. It may be calculated by dividing the sum of the scores by the number of scores. An advantage of the mean is that it can be calculated without arranging the data in order. The main disadvantage of the mean is that it may be skewed or overly influenced by extreme scores.

Measures of variation or dispersion show how uniform the data are. Are most of the scores clustered near the mean, or do they cover a broader area? The range shows the distance between the largest and smallest observation and is easy to calculate. However, range is very sensitive to changes; a single measurement can change the range drastically. Dispersion may be illustrated by using graphing calculators or computers to generate box-and-whisker plots, which create a visual display of the median, the quartile range, and the extrema.

Lesson Outline

The first two lessons provide students with experiences in collecting and analyzing data using basic descriptive statistics. In the introductory lesson, the students learn techniques of chocolate chip counting and become familiar with the terms mode, median, mean, and range.

In the second lesson, students learn how to handle multiple sets of data as they count chips in several brands of cookies. Other variables are introduced in order to present the question of what the statistics on number of chocolate chips actually mean.

The third lesson involves consumer analysis as students compare data on chocolate chip cookie prices; they examine the impact on price of such variables as location of store, type of store, ingredients, and serving size. Taste-testing provides a pleasant extension of this lesson.

In *Part II: Investigating Snacks*, chocolate chip cookies are compared to other snacks in terms of price and nutritional value. Students use information on the Food Guide Pyramid and nutritional labeling to make snack choices. (Part II will be published in the April 1995 issue.)

Parent Letter

Before you begin these lessons, you may want to send a letter home to parents explaining what you will be doing over the next few weeks and asking for their cooperation. Because these activities may involve several trips to the grocery store, parental involvement is necessary. If parents are given plenty of advance notice, they may be more willing to help. In the letter, tell parents that the class is beginning a consumer unit

and that children will have to gather information from the grocery store and home. Depending upon which lessons and extensions you decide to do, children would need to gather information on the price of a specific brand of chocolate chip cookies (Lesson 3) and buy and/or make chocolate chip cookies (extension activity in Lesson 3).

Lesson 1

Purpose: In the introductory lesson, children practice data collection techniques and learn to find the range, mode, median, and mean of an interval data set.

Time: 45 minutes plus additional time for group or individual work in extension activities.

Materials/Supplies (for each child):
one chocolate chip cookie
paper towel
toothpick (optional)
paper and pencil
calculator

Procedure

After the materials have been passed out, ask the children what they notice about the cookie on the paper towel. They may say that some chips are large, some hidden, and some broken. After the children discuss their observations, explain that their task is to count all of the chips in their cookie. Set some guidelines: for example, only whole chips can be counted, cookies can be taken apart, and nothing can be eaten until permission is given.

After the children have counted the chips and recorded the number, brainstorm with the class how to represent the data. If children are not experienced with graphing, it may be best to act it out: On a large piece of paper, each child writes the number of chips counted and then lines up according to the number, lowest to highest, with duplicates standing behind each other.

The various types of statistics can also be acted out. Using the human graph, direct the children's attention to the lines indicating the smallest and the largest number of chips; these two numbers set the parameters for the range. Then have them identify the longest line. Explain that statisticians call the number that occurs most often the mode. Next, line them up in single file, keeping them in order from the lowest number of chips to the highest number of chips. Count to see which person is in the very middle of the group; the number of chips in this person's cookie is the median.

To find the mean, explain that the children need to add each individual tally and divide the total by the number of children. To illustrate this concept, give each child counters to correspond to the number of chips she/he had. Then, collect all of the counters in a container. Have each child go by the container and take out one counter. Do this again and again until all of the counters are gone. If the counters divide up evenly, the mean corresponds to the number of counters each child has. If the counters don't divide up evenly, the number of counters the children have will differ by one. The mean falls between the two different whole numbers.

The data may also be displayed on the blackboard; a graph can be constructed by adding the data from each child to the appropriate column. Ask the children what they notice about the data. The discussion may be guided to include references to the range, mode, median, and mean by questions and statements such as "What was the smallest number of chips?", "What was the most?", "Look, five people each had twelve chips." If the children are not familiar with the statistical terms, introduce them during the discussion and ask the students to calculate each one. Box-and-whisker plots may be used to illustrate the dispersion of the data.

Evaluation

Each lesson's learning may be evaluated by having students keep a journal of the investigative processes involved in this unit. The journal can include descriptions, graphs and charts, computations, and conclusions.

For Lesson 1, the journal can include a description of the chocolate chip counting technique and the statistical procedures used. Students can provide their own definitions of the terms mode, median, mean, and range and tell what the results were for each one. They can also include data from any extension activities. If they do any of the investigations suggested in the extensions section of this lesson, the journal should include a description of the investigation, a graph of the results, statistical computations, and final conclusions.

Extensions

1. The picture book *Averages* (Srivastava, 1975) or the short novel *What Do You Mean By "Average"?* (James & Barkin, 1978) can be used to introduce the concepts of mode, median, and arithmetic mean and to show how each type of average may work best for a particular situation. Both books give examples of activities using averages. Bradden, Hall, and Taylor (1993) provide other examples of activities involving averages which can be used in conjunction with these

books or on their own.

2. Other investigative activities can also help to reinforce these concepts. For example, children could collect data on the number of siblings their classmates have, the length of each person's hair, how many times they can hop in thirty seconds, how many pets they have, the number of buttons on their clothing that day, the number of pencils in their desks, their height in centimeters, how many times they can jump rope without stopping, how many jelly beans they can scoop up in one hand, or the number of baskets they can shoot in a row. Students can work on these projects individually or in small groups; after collecting and analyzing their data, they could write a report on their findings to present to the class.

Lesson 2

Purpose: Students collect data from three different sources and compare the results in order to learn how to analyze patterns in the data. Students evaluate the significance of their results as they discuss what the data tell them. They consider whether the data answer the most important questions; for example, do data on number of chips tell which is the best cookie?

Time: 45-60 minutes.

Materials (for each child):
one each of three different brands of chocolate chip cookies (if possible, get cookies that vary in price)
3 paper towels
toothpicks
paper and pencil
calculator

Procedure

Have the children label their paper towels A, B, and C. Without letting them know what the brands are, distribute the cookies to the children one brand at a time, making sure that the first cookie is placed on Towel A, the second on B, and the third on C. The children then count and record the number of chips per cookie. After counting, the cookies may be eaten; ask the children to record which they liked the best.

Brainstorm with the children the best way to display and analyze the data on number of chips. It may be simplest to make a separate bar graph for each type of cookie; this method has the advantage of retaining each individual's data. Regardless of how the children choose to display their results, the data should be clear and easy to understand. Have the children calculate the median, mode, mean, and range for each type of cookie and then discuss what information each of these statistics provides. By looking at the data for each cookie, can children tell which brand was the most uniform in terms of the number of chips? Discuss whether the cookie with the most chips was the best cookie. Then, introduce the variable of price; either provide or have the children calculate the price per ounce of each brand. Was the most expensive cookie the class favorite?

Evaluation

For Lesson 2, children can write a description of the data analysis for number of chips per brand of cookie as well as children's preferences. They should include the statistical techniques used and their own conclusions. Ask them to write a paragraph or two on "The Ideal Chocolate Chip Cookie."

Lesson 3

Purpose: Students use their problem-solving skills to become better consumers. They also practice computational skills as they compare cookie prices and analyze variables.

Time: Two or three 45-minute sessions plus student time outside of class.

Materials (for the class):
information on prices of cookies (provided by students and teacher)
Price Comparison Chart poster and worksheets (See Figure 1)

Materials (for each child):
samples of cookies (if possible)
paper and pencil
calculators

Procedure

After completing Lesson Two, tell the children that their homework assignment is to research the price of chocolate chip cookies. Each child should bring in information on the price per ounce of at least one brand or type. Discuss with the children the different places that they can buy cookies; the list may include grocery stores, discount stores, bakeries, malls, and specialty shops. The survey should include data from as many locations as possible and from store brands or generic labels as well as name brands. List these on the Price Comparison Chart poster and have each child pencil his/her name in a specific block in order to cover all

Figure 1. *Price Comparison Chart.*

PRICE COMPARISON CHART[1]

Store / Type of cookie	Kroger	National	Shop Rite	Walmart	K-Mart	Cristaudo's Bakery	Cookie Shoppe	Other
Chips Ahoy (16 oz)								
Chips Ahoy (12 oz)								
Chips Deluxe								
Big Value								
Kroger								
National								
Cost Cutter								
Specialty Cookies								
Other								

[1]All prices are expressed as cents per ounce. Indicate if price reflects specail sale or use of coupon.

possibilities and avoid duplications.

Ask the children what information they should write down; if they don't mention these points, instruct the children to record the specific name of the cookie (e.g., Chips Ahoy Reduced Fat), the size of the package, the price per ounce, where they saw the cookie, and any other information. For convenience, the price per ounce should be rounded up or down to the nearest cent.

Give the children several days to collect their data. As their data is brought in, have them post the information on the Price Comparison Chart. When the poster is complete, make individual charts for each of the students so that they can study it.

Ask the students how they could calculate the mean, median, mode, and range for this data and what significance these statistics would have. Would each of these statistics be useful? Posing the problem in concrete terms may make it easier for students to think about it. For example, tell them that they are managers of a new grocery store and that they need to figure out what price to charge for the Chips! Chips! Chips! brand of cookies. They would probably need to consider the price charged for these cookies at other local stores; what statistics should they use to summarize their findings on other stores' prices? Or tell your students that they are regional sales representatives for Cookies Incorporated. The national office needs a written

report on selling prices of their Chips! Chips! Chips! line. Ask students to provide an outline of the statistics used in the report and how they should be interpreted.

Then, have the children re-examine the Price Comparison Chart; do the children see any patterns? For example, what is the cheapest cookie? The most expensive cookie? What differences are there between the most and least expensive? Which variables might affect price? How does the price of a particular brand at a discount store compare with the same brand at a grocery store? Does package size affect price? What is the price of the children's favorite cookie? The discussion eventually may lead to why students choose one cookie over another. What makes a good cookie? Do the students agree, or does it depend on individual preferences?

Evaluation

For Lesson 3, journal writing can include the process of collecting, displaying, analyzing, and discussing their cookie data as well as their store manager's or national sales representative's report on the Chips! Chips! Chips! data. Were there any surprises during this process? Did they enjoy being investigators? What did they find out about cookies and about data? In the future, how would they decide which cookie to buy or which cookie to recommend to their parents or others? Have their ideas about the "ideal cookie" changed since their entries from Lesson 2?

Extensions

1. Taste-testing is an excellent follow-up to price comparisons; this is research which children enjoy! In order to minimize the cost, see if the children can bring in cookies or if stores will make donations. Try to get a variety of cookies in different price ranges. Homemade cookies from one or more recipes add to the variety. How are the cookies different? Variables might include the size, softness, number or size of chips, the addition of nuts or other ingredients, freshness, etc. When taste-testing, give out small samples, if possible identified by a code. Which is the students' favorite? Why? If cookie samples are coded, can they identify the cookies they've sampled?

2. Students can make their own chocolate chip cookies, perhaps comparing different recipes. They can also calculate the price per ounce of the homemade cookies. What costs should be included in their calculations?

3. Take a field trip to a bakery or get a speaker such as a baker or grocer to talk about how the price of cookies is determined.

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