Candy Judging

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Overview of Lesson
In this activity, students conduct an investigation to determine which of four chocolate candies is preferred. Each student will taste one each of four candies and will rate them from most to least favorite. Students will then construct a picture graph and a bar graph to determine which types of chocolate were selected as the most and least favorite. Students will also generate a method to decide which candy was the overall class favorite. Conclusions are drawn based on the analysis in the context of the question(s) asked.

GAISE Components
This investigation follows the four components of statistical problem solving put forth in the *Guidelines for Assessment and Instruction in Statistics Education (GAISE) Report*. The four components are: formulate a question, design and implement a plan to collect data, analyze the data by measures and graphs, and interpret the results in the context of the original question. This is a GAISE Level A activity.

Common Core State Standards for Mathematical Practice
1. Make sense of problems and persevere in solving them.
4. Model with mathematics.
5. Use appropriate tools strategically.

Common Core State Standards Grade Level Content (Grades 3 through 5)
3. MD. Represent and interpret data.

NCTM Principles and Standards for School Mathematics
Data Analysis and Probability Standard for Grades 3-5
  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.
  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;
  - compare different representations of the same data and evaluate how well each representation shows important aspects of the data.

Prerequisites
Students will have experience collecting data and constructing basic graphs (dotplot, bar graph, picture graph) of categorical data.

Learning Targets
Students will correctly determine an appropriate graph to display categorical data and will interpret the data given specific criteria.

Time Required
One class period.

Materials Required
- Four types of Snack-size chocolate candies (suggested candies include Hershey® Milk Chocolate, krackel®, mr. Goodbar®, Special Dark®). When selecting candy, choose chocolates with distinct taste/characteristics, but similar size and wrapping.
- Post-it notes
- Markers
- Tape
- Plastic cup (to hold candies during the experiment)
- Data recording sheet
- Poster board to display data

Instructional Lesson Plan

The GAISE Statistical Problem-Solving Procedure

I. Formulate a Question
Begin the lesson by formulating a hypothetical situation: The class is in charge of deciding what type of chocolate candy best represents the favorite candy for students in their grade level. Show students the four types of chocolates (make sure that nobody is allergic to nuts) and ask students to generate questions that they might ask to help them determine which chocolate is the class favorite.

Possible questions might include:
1. Which candy do you think the class will like best?
2. Which candy do you think the class will like least?
3. If we were to select one candy bar to serve as a treat in our class, which one do you think we should choose?
4. Which candy bar should we not select as a treat for our class?

II. Design and Implement a Plan to Collect the Data
Explain to the class that they will conduct an experiment to help determine which chocolate candy is the class favorite. Guide the students in setting up an investigation to determine which chocolate is their favorite. Put students in pairs and give each pair two plastic cups each holding

one of each type of the four candies. Each student should also receive a marker and four post-it notes for recording their favorites.

The first student (the taster) in each pair should close his/her eyes (and keep them closed during the experiment), then reach into the plastic cup and randomly select the first chocolate bar. The second student (the recorder) sets the wrapper aside, noting that it was the first chocolate sampled. The process repeats until the taster has tasted all four chocolates. The taster then ranks the chocolates from most favorite (1) to least favorite (4). Remind students that there can be no ties. Note: the taster may or may not be able to identify the name of the chocolate by taste and may refer to the chocolates in terms of the order in which they were sampled. For example, "I like the second chocolate best." The recorder will place the rank with the name of the candy. The students will then change roles and repeat the experiment. Remind students that there are no wrong answers and that it is important that their rankings be independent.

After everyone has had a chance to taste and rank the candies, collect and record the class data. Note that this is a census of the class because data is gathered from every student in the class.

III. Analyze the Data
Ask students whether the data presented on the data recording sheet answers the question about which chocolate is the favorite. If the response is positive, ask which candy is the favorite and which is least favorite. Be sure to ask what they based their responses on. One possible method is the sum of the responses (lowest sum = favorite, highest sum = least favorite).

Another method of describing the data is by using a picture graph. A picture graph refers to a graph where an object is used to represent one individual on a graph. The picture graph is a variation on the dot plot and bar graph. In this scenario, each student takes the candy wrapper of their favorite chocolate and places it in the appropriate category on the graph. Remind students to space the wrappers evenly and vertically. Students should also make a picture graph of the least favorite candy.

A more advanced method of describing the data is by using a bar graph. Students should construct a bar graph for each type of candy and use it to compare the distributions.

IV. Interpret the Results
The teacher next facilitates a discussion about which chocolate is most/least favorite, using the recorded data to help answer the questions. There should be a discussion about how to best interpret the data.

For example, some students might think that the best way to determine the favorite chocolate is to see which one had the most scores of 1. The teacher should use the word "mode" to describe the candy that has the most scores of 1. Students should recognize that this candy has the highest bar on a bar graph. The teacher might ask for some disadvantages of using the mode to determine the class favorite. For example, this doesn't take into account that the first choice of most students may be the least favorite of many classmates.

Other students might think that the sum of the scores should be used to determine the class favorite.   An advantage of this approach is that all scores would be used to determine the favorite.

Another approach to determine the class favorite is to use the median. Although the data in this set is categorical, it can be placed in order numerically from most to least favorite. The median score for each candy is determined by the middle number in the data set if there is an odd number of data points, and by the average of the two middle numbers if there is an even number of data points.

Assessment

1. Jeremy's class rated the chocolate candies according to the scale described above. His class data is recorded in the chart below.

	Special Dark®	krackel®	mr. Goodbar®	Milk Chocolate
Jeremy	1	2	3	4
Kayla	4	2	3	1
Quentin	1	2	3	4
Ken	4	3	1	2
Jake	1	3	4	2
PollyAnn	1	2	3	4
Rocco	1	3	2	4
Drake	4	2	1	3
Corrine	1	2	3	4
Kris	4	2	1	3
Mary	4	3	2	1
Casey	1	3	4	2
Mel	4	3	2	1
Lisa	1	3	2	4
Cindy	4	2	1	3

Use the approaches below to determine the class favorite.

(a) Find the chocolate that was selected as favorite (ranked with a 1) the most often. Represent this data in a picture graph (or dotplot). Which candy would represent the class favorite if this method were used to determine the favorite?

(b) Find the chocolate that was selected as least favorite (ranked with a 4) the most often. Represent this data in a picture graph (or dotplot). Which candy would represent the least favorite of the class if this method were used to determine the least favorite?

(c) Find the sum of the scores of the rankings. Which chocolate would represent the favorite if the sum of the class scores was used to determine the favorite? Which chocolate would be the least favorite using this method?

(d) Find the median score of each type of chocolate. Which chocolate would represent the favorite if the median was used to determine the favorite? Which chocolate would represent the least favorite if the median was used to determine the favorite?
(e) Draw a bar graph of the score distribution for each candy. Which chocolate do you think would represent the favorite if you use the bar graphs to compare them?

Answers

(a) Special Dark® was selected as the favorite the most often.

```
X
X
X
X
X                              X
X                              X          X
X                              X          X
X                              X          X
_____
Special                              Milk
Dark         krackel®     mr.Goodbar   Chocolate
```

Type of Chocolate Bar

(b) Special Dark® was selected as the least favorite most often.

```
X
X                                              X
X                                              X
X                                              X
X                                              X
X                              X               X
X                              X               X
_____
Special                        mr.             Milk
Dark®        krackel®       Goodbar®      Chocolate
```

Type of Chocolate Bar

(c) The sum of the scores are shown. Based on this, the class favorite would be mr. Goodbar®, and the least favorite would be Hershey® Milk Chocolate.

Special Dark®	krackel®	mr. Goodbar®	Milk Chocolate
36	37	35	42

(d) The median score of each chocolate is shown below. Based on this, there would be a three-way tie for class favorite, and the least favorite would be Hershey® Milk Chocolate.

Special Dark®	krackel®	mr. Goodbar®	Milk Chocolate
1	2	2	3

(e) Bar graphs for each candy are shown. Answers will vary as to which candy should be selected as most/least favorite.

Special Dark®

krackel®

mr. Goodbar®

Hershey® Milk Chocolate
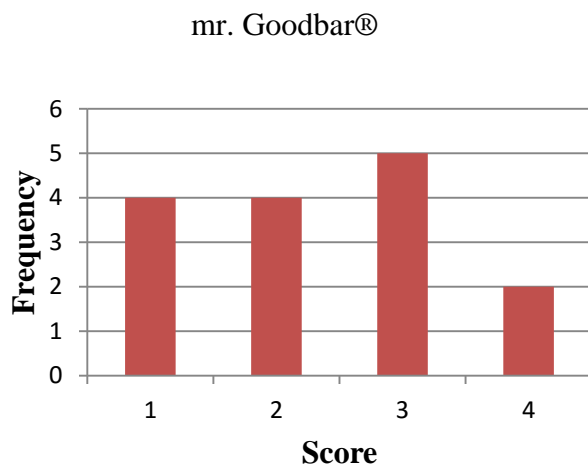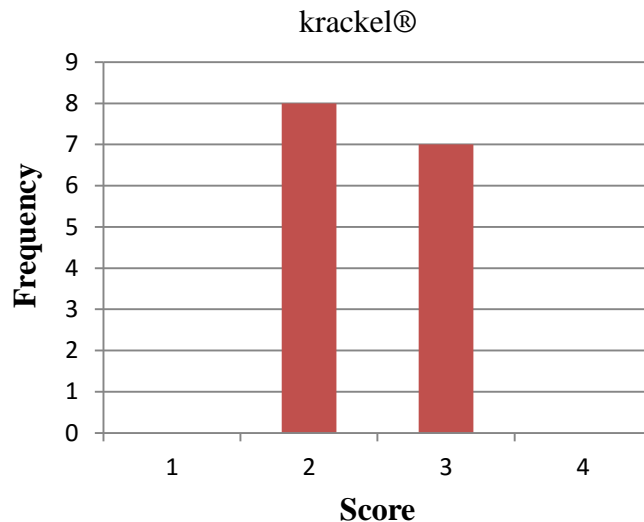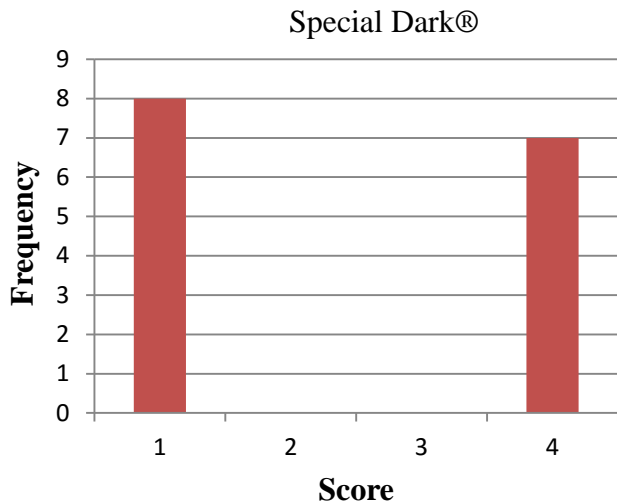
Possible Extensions

1. After the bar graphs are constructed, the teacher can ask students to describe the shape of each distribution.

2. Students can represent their first choices (favorite) and last choices (least favorite) in a circle graph. They can then calculate the measures of the central angles of each sector.

3. This activity can be extended to earlier grade levels by simply asking students to select their favorite chocolate. A dotplot of the students' favorite candy can be constructed so that students can describe the class data.

References

Adapted from an activity created by Paul J. Fields, Ph.D. for the *American Statistical Association Meeting Within a Meeting Program for Middle School Teachers* (2008).

Candy Judging Activity Sheet

1. What are some questions that we might ask to help us determine which of these chocolates is our class favorite?

2. Write your rating of each candy on the class recording sheet.

3. Tally each response in the table below.

	Special Dark®	krackel®	mr. Goodbar®	Milk Chocolate
1				
2				
3				
4				

4. Complete the table below showing the frequency of each rating.

	Special Dark®	krackel®	mr. Goodbar®	Milk Chocolate
1				
2				
3				
4				

5. Construct a dotplot of the chocolates that received a rating of 1. Which candy would be rated the class favorite based on this graph?

Special Dark®	krackel®	mr. Goodbar®	Milk Chocolate

6. Construct a dotplot of the chocolates that received a rating of 4. Which candy would be rated the least favorite based on this graph?

Special Dark®	krackel®	mr. Goodbar®	Milk Chocolate
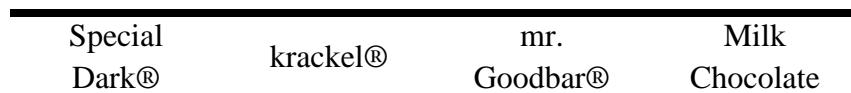
7. Find the sum of the scores of the rankings.

Special Dark®	krackel®	mr. Goodbar®	Milk Chocolate

Which chocolate would represent the class favorite based on the sum of the scores?

Which chocolate would represent the least favorite based on the sum of the scores?

8. Find the median score of each type of chocolate.

Special Dark®	krackel®	mr. Goodbar®	Milk Chocolate

Which chocolate would represent the favorite if the median was used to make this decision?

Which chocolate would represent the least favorite if the median was used to make this decision?

9. Draw a bar graph of the score distribution for each candy.   Which chocolate do you think would represent the favorite if you use the bar graphs to compare them?

Special Dark®

1	2	3	4
Score

krackel®

1	2	3	4
Score

mr. Goodbar®

1	2	3	4
Score

Hershey® Milk Chocolate

1	2	3	4
Score

Class Recording Sheet

Chocolate → Student Name	Special Dark®	krackel®	mr. Goodbar®	Milk Chocolate