Bubble-Maniacs

Brief Overview:

In this unit students will collect data on the size of soap bubbles. Using different variables such as mystery ingredients and varying soap brands, students will collect data on bubbles and make line plots, bar graphs, and box plots as well as calculate measures of central tendency. Students will be required to write a paragraph explaining their choice for the best large bubble blowing solution.

NCTM 2000 Principles for School Mathematics:

- **Equity:** *Excellence in mathematics education requires equity - high expectations and strong support for all students.*
- **Curriculum:** *A curriculum is more than a collection of activities: it must be coherent, focused on important mathematics, and well articulated across the grades.*
- **Teaching:** *Effective mathematics teaching requires understanding what students know and need to learn and then challenging and supporting them to learn it well.*
- **Learning:** *Students must learn mathematics with understanding, actively building new knowledge from experience and prior knowledge.*
- **Assessment:** *Assessment should support the learning of important mathematics and furnish useful information to both teachers and students.*
- **Technology:** *Technology is essential in teaching and learning mathematics; it influences the mathematics that is taught and enhances students' learning.*

Links to NCTM 2000 Standards:

Content Standards

<u>Algebra</u>

- *Use mathematical models to represent and understand quantitative relationships; and model problem situations with objects and use presentations such as graphs, tables, and equations to draw conclusions.*
- *Analyze change in various contexts; investigate how a change in one variable relates to a change in a second variable; and identify and describe situations with constant or varying rate of change and compare them.*

<u>Measurement</u>

- *Apply appropriate techniques, tools, and formulas to determine measurements, develop strategies for estimating the perimeters, areas, and volumes of irregular shapes; select and apply appropriate standard units and tools to measure length, area, volume, weight, time,*

temperature, and the size of angles; and select and use benchmarks to estimate measurements.

Data Analysis and Probability

- *Formulate questions that can be addressed with data and collect, organize and display relevant data to answer them; collect data using observations, surveys, and experiments; and represents data using tables and graphs such as: line plots, bar graphs, and line graphs.*
- *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 data are distributed; use measure of center, focusing on the median and understand what each foes and does not indicate about the data set; an compare different representations of the same data and evaluate how ell each representation shows important aspects of the data.*
- *Develop and evaluate inferences and predictions that are based on data; and propose and justify conclusions and predictions that are based on data and design studies to further investigate the conclusions or predictions.*

- **Process Standards**

Problem Solving

- *Instructional programs from pre-kindergarten through grade 12 should enable all students to build new mathematical knowledge through problem solving; solve problems that arise in mathematics and in other contexts; apply and adapt a variety of appropriate strategies to solve problems; and monitor and reflect on the process of mathematical problem solving.*

Reasoning and Proof

- *Instructional programs from pre-kindergarten through grade 12 should enable all students to recognize reasoning and proof as fundamental aspects of mathematics; make and investigate mathematical conjectures; develop and evaluate mathematical arguments and proofs; and select and use various types of reasoning and methods of proof.*

Communication

- *Instructional programs from pre-kindergarten through grade 12 should enable all students to organize and consolidate their mathematical thinking through communication; communicate their mathematical thinking coherently and clearly to peers, teachers, and others; analyze and evaluate the mathematical thinking and strategies of others; and the language of mathematics to express mathematical ideas precisely.*

Connections

- *Instructional programs from pre-kindergarten through grade 12 should enable all students to recognize and use connections among mathematical ideas; understand how mathematical ideas interconnect and build on one another to produce a coherent whole; and recognize and apply mathematics in context outside of mathematics.*

Representation

- *Instructional programs from pre-kindergarten through grade 12 should enable all students to create and use representations to organize, record, and communicate mathematical ideas;*

select, apply, and translate among mathematical representations to solve problems; and use representations to model and interpret physical, social, and mathematical phenomena.

Grade/Level:

Grades 4-6

Duration/Length:

This unit contains four lesson plans lasting 4 to 5 days.

Prerequisite Knowledge:

Students should have working knowledge of the following skills:

- Measurement
- Diameter
- Addition and Division for calculating mean
- Experience in Collecting and Organizing Data

Student Outcomes:

Students will:

- Compare data sets to answer a question
- Organize and display data using line plots, bar graphs, and box plots
- Analyze and interpret line plots, bar graphs, and box plots
- Find the mean, median, mode and range of a data set
- Use mathematical language and symbolism appropriately
- Present results in written format
- Justify why an answer is reasonable

Materials/Resources/Printed Materials:

- Water
- A variety of dish soap (Joy, Dawn, Palmolive, store brand, etc)
- A variety of substances to test for bubble enhancement (glycerin, vegetable oil, sugar, salt, Karol syrup, rubbing alcohol, etc.)
- Bowls
- Paper towels
- Straws
- Rulers
- Post-It Notes
- Student resource sheets
- Calculators if needed

Development/Procedures:

Day One

- Motivate students by using a wand and bubble solution to blow some bubbles. You may want to include some interesting or unusual wands. Ask students to give examples of how bubbles can be used for play.
- Introduce the vignette found on Teacher Resource Sheet # 1 to students. Explain that they will be involved in a bubble contest at the end of the unit and they will be allowed to make their own bubble recipe using three ingredients; water, dish soap, and one-half teaspoon of one other ingredient. Their task over the next few days will be to collect data on different bubble recipes so that they will be able to make a better choice for prize winning bubble solution ingredients.
- Ask students to brainstorm ways to measure a bubble. Show students how to measure the diameter of a bubble print. Students should use a paper towel to wet a hard surface with the bubble solution. The more wet and soapy the surface is, the easier it will be to measure the print! Students should dip a straw into the bubble solution and then begin to blow a bubble on to the wet surface. They may take as many breaths as needed but should keep blowing until the bubble pops. The popped bubble will make a circle print on the wet surface which is easily measured. Show students how to measure the diameter of the print by placing their ruler from one point on the circumference, through the midpoint and then on to the opposite side.
- Tell students they will be gathering data that will provide a base line for making their special bubble solutions. Give each group of students a basic bubble solution consisting of one cup of water and two tablespoons of liquid dish soap. Make sure each group uses the same brand of dish soap for this activity. Each student should blow at least one bubble and record the diameter measure on a post-it note. Students should place the post it notes on the board.
- Explain to students that the data on the board is difficult to read and should be organized. Have students organize the data in order from least to greatest.
- Have students find the range of the data by subtracting the measure of the smallest diameter from the measure of the largest diameter. Draw a number line at the bottom of the chalkboard that begins at the lowest value and ends at the highest value. For example, if your students have data ranging from 8 cm to 25 cm begin the number line at 8 and continue to at least 25.
- Have students find the median of the data. The median is the measurement that lies in the middle after the measurements are ordered from smallest to largest. If there are two measurements in the middle, the median is the midpoint between the two. Half of the data points will be equal to or lower than the median and half of the data points will be equal to or greater than the median.
- Have students find the mean of the data by adding the diameters and dividing by the total number of data values.
- Ask students to state the bubble size that was blown most often by finding the most frequent diameter. Explain to students that the most frequent number represents the mode of the data set. Have students move their post it notes to the corresponding number on the number line. If there is more than one piece of data with the same number they should be placed on top of each other. The students should easily be able to see the mode of the data set. If there are two modes, the data set is said to be “bi-modal”.
- Explain to students that they have just constructed a line plot. Have each student draw the class line plot on Student Resource Sheet # 1 and then write sentences or a paragraph

describing the data. Use the rubric found on Teacher Resource Sheet # 2 to score the line plot.

- Ask students to use the data to predict the measure of the winning bubble for the Bubble-Maniac Contest.

Day Two

"Can We Make a Bigger Bubble?"

- Remind students that their bubble mixture will also include an additional ingredient to the water and soap. Each mixture is allowed to include one-half teaspoon of one other ingredient. Ask students to brainstorm ideas for additional ingredients.
- Tell students that they will be testing various ingredients to determine which ingredient(s) make bigger bubbles. They will be collecting data on the sizes of the bubbles made with each ingredient and then calculate range, median, mode, and mean. They will also display their group data as well as make a display for the class data.
- Divide the class into groups. Each group will test a mixture consisting of the same bubble recipe used in Day One with a different half-teaspoon "mystery" ingredient added. Be sure to use the same brand of dish soap used in the activity for Day One. Test as many ingredients as you have groups. Examples of ingredients would be sugar, salt, Karo syrup, oil, rubbing alcohol, and glycerin. You may want to put the name of the "mystery" ingredient in a sealed envelope to be opened after all data has been collected and conclusions have been drawn.
- Have groups of students test the effect of the "mystery" ingredient on the bubble mixture by repeating the bubble blowing experiment with the new mixtures. Each group should record the diameter of at least 25 bubbles on Student Resource Sheet # 2. After gathering the data, students should make a line plot of their results and calculate the mean, median, mode, and range on Student Resource Sheet # 3.
- Have each group present the results of their experiment to the class. Line plots from each group should be posted on the board for comparison. As groups of students present their results, each student should record group results on Student Resource Sheet # 4.
- Tell students that a bar graph will help us to "see" the data and draw conclusions about the median size of the bubbles blown with each mystery ingredient. Use Student Resource Sheet # 5 to construct a bar graph of the median data. Have students construct a scale for the vertical axis and label it with the phrase, "Median Diameter size of Bubbles in Centimeters". The horizontal axis will be marked with "Mystery Ingredient #1", "Mystery Ingredient #2"etc. and be labeled "Mystery Ingredients". Be sure to include a title for the graph.
- Ask students to draw conclusions about the results based on the bar graph. Did one ingredient produce significantly larger bubbles than the other ingredients? Did one ingredient produce significantly smaller bubbles than the other ingredients? Does the addition of a large bubble-producing ingredient guarantee a larger bubble?
- Reveal the identity of each mystery ingredient. Allow students to discuss any insights or surprises about the results.
- Have students write a paragraph or sentences describing the bar graph and drawing conclusions. Use the rubric found on Teacher Resource Sheet # 3 to score the bar graph.

Day Three

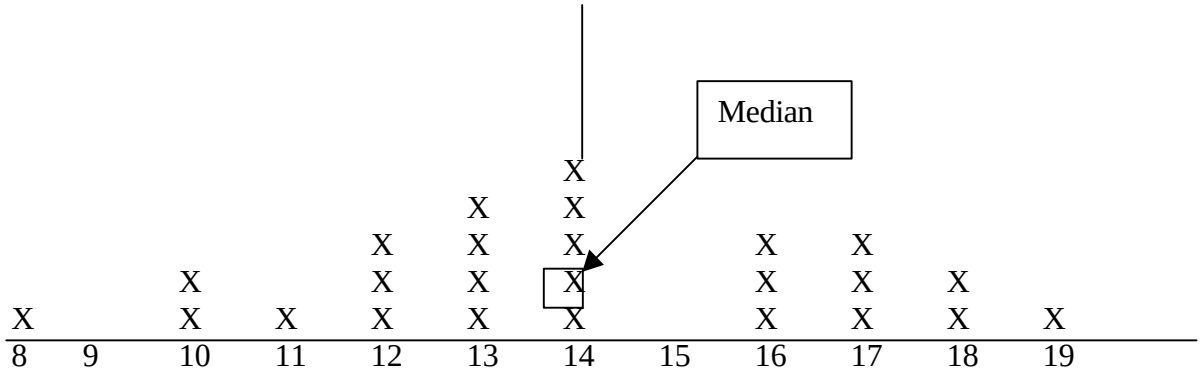
"Can We Make an Even Bigger Bubble?"

Note to Teacher: You may substitute the box and whisker plot in this portion of the lesson

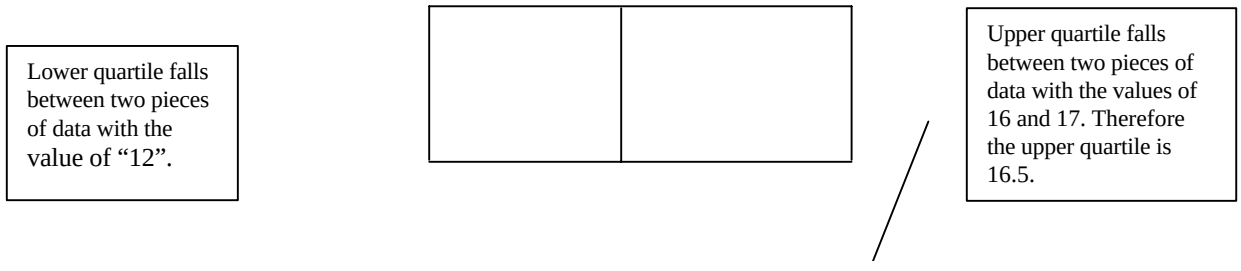
for a class bar graph showing results from all groups if your students are not ready for this skill.

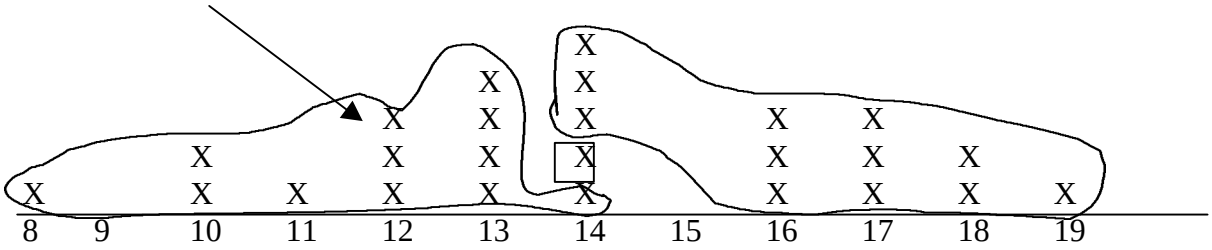
- Choose one of the best performing mystery ingredients from Day Two. Tell students that there is one other ingredient that can be tested for bubble performance. Ask students if the choice of dish soap might make a difference.
- Divide students into groups and give each group a solution consisting of the one cup water, one-half teaspoon of the chosen added ingredient, and two tablespoons of a different brand of dish soap.
- Have groups of students test the effect of the various brands of dish soap on the bubble mixture by repeating the bubble blowing experiment. Each group should record the diameter of at least 25 bubbles on Student Resource Sheet # 6. After gathering the data, students should make a line plot of their results and calculate the mean, median, mode, and range on Student Resource Sheet # 7. For comparison reasons, it is best to have all students use the same range of values for their number line plots.
- Demonstrate how to make a box plot (box and whisker plot) of the collected data using the line plots as a base. You may wish to use a fictitious set of data for demonstration and then allow students to construct their own box and whisker plots using their collected data.

    - In the space above the line plot, make a vertical line above the median of the data. By finding the median the students are cutting the data in half and the horizontal line defines that separation.

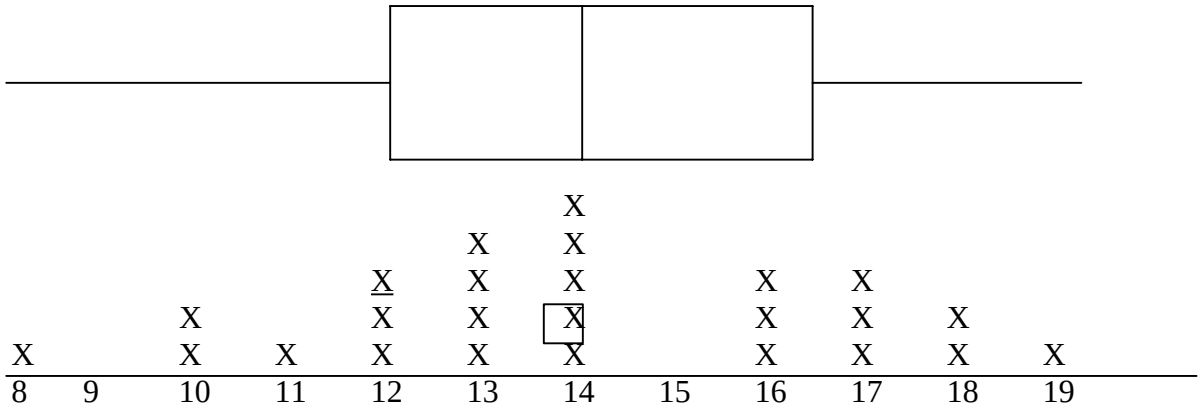


    - Have students look at the lower half of the data. Ask students to find the median of the lower half of the data and draw a vertical line above this number. Have students do the same procedure for the upper half of the data. The students have now divided the data into quarters called quartiles. The lower line represents the lower quartile and the upper line represents the upper quartile. Draw horizontal lines to connect the horizontal lines into a box. The box represents the middle half of the data set.





- Demonstrate the final step by having students draw a horizontal line from the lower quartile line to directly above the lowest data value. Repeat the process from the upper quartile line to the highest data value. These horizontal lines are the whiskers of the box and whisker plot. The lowest data value is the lower extreme and the highest data value is the upper extreme. Each extreme represents one quarter of the data.



- Have students make box plots for their group data above the line plot on Student Resource Sheet # 7.
- Show students how they can compare there box plots to make conclusions by lining them up along the same number line. The better performing dish soaps will have boxes that are located higher on the number line.
- Student should collect comparison data from other groups using Student Resource Sheet # 8.
- Have students write a paragraph or sentences describing their plots and indicating their choice of dish soap for their bubble solutions.
- Use the rubric found on Teacher Resource Sheet # 4 to score box plots.

Day Four

"Can You Make a Prize Winning Bubble Solution?"

- Have students use their data, graphs, and class discussion about results to choose a bubble recipe that they believe will produce the prize-winning bubble. Students will make their solutions and write their recipe on Student Resource Sheet # 9. They should then write a

paragraph explaining their ingredient choice and use the collected class data for support. Score this paragraph according to the rubric on Teacher Resource Sheet # 5.

- As the culminating event for the unit, hold the Bubble Maniac Contest. Each student will be given three tries to blow a bubble. The largest diameter of the three tries will be their score.

Performance Assessment:

- Continuous assessment throughout all activities using teacher observation.
- Accuracy in completing line plots using the rubric on Teacher Resource Sheet # 2.
- Accuracy in completing the bar graph using the rubric on Teacher Resource Sheet # 3.
- Accuracy in completing the box and whisker plot using the rubric on Teacher Resource Sheet # 4.
- Accuracy in finding and calculating range, median, mean, and mode.
- Assessment using the rubric scoring for the paragraph using Teacher Resource Sheet # 5.

Extension/Follow Up:

- Construct parallel box plots of the data.
- Construct double bar graphs showing multiple ingredients.
- Investigate the science of bubbles using activities in the AIMS Publication Soap Films and Bubbles by Ann Wiebe.

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Vignette

Next week the school will be having a contest to create the biggest bubble. Our class wants to win. You are going to be able to test different bubble solutions to determine which solution would create the biggest bubble. Using class data you will write a paragraph explaining your choice of ingredients for your bubble solution.

START BLOWING!

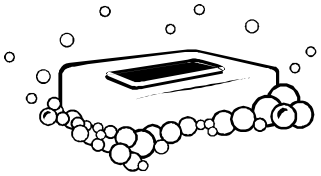
Student Resource Sheet # 1

Name
Date

Data Collection for Soap and Water Bubbles
Class Data

_____

Range
Mode
Median
Mean



On the back, write a paragraph about the data from the line plot. Be sure to include math terminology. Based on the data, write a prediction about the size of the winning bubble in the BubbleManiac contest.

Teacher Resource Sheet # 2

Rubric For Line Plot

3 Points

Graph Title
X-axis Labeled
Range, median, mode, and mean are correct

2 Points

5 of the elements listed are correct.

1 Point

3 of the elements listed are correct.

0 Points

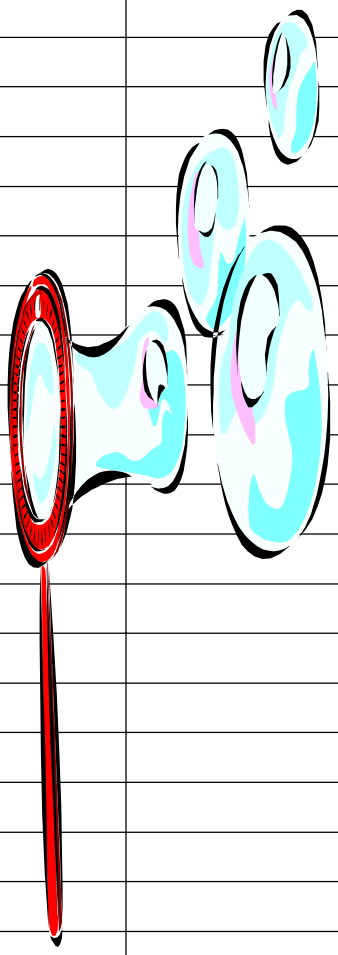
Less than 3 elements correct.

Student Resource Sheet # 2

Can We Make a Bigger Bubble?

Mystery Substance

Number of Trial	Diameter (cm)
Trial 1	
Trial 2	
Trial 3	
Trial 4	
Trial 5	
Trial 6	
Trial 7	
Trial 8	
Trial 9	
Trial 10	
Trial 11	
Trial 12	
Trial 13	
Trial 14	
Trial 15	
Trial 16	
Trial 17	
Trial 18	
Trial 19	
Trial 20	
Trial 21	
Trial 22	
Trial 23	
Trial 24	
Trial 25	



Student Resource Sheet # 3

Data Collection for Soap, Water, and Mystery Substance Bubbles

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Range
Median

Mode
Mean

On the back, write a paragraph about the mystery substance data. Be sure to include data from your investigation. Make a prediction about the identity of the mystery substance in your bubble solution. Be sure to use math terminology.

Student Resource Sheet # 4

Data Collection for All Mystery Substances

Measures	Mystery Substance 1	Mystery Substance 2	Mystery Substance 3	Mystery Substance 4	Mystery Substance 5	Mystery Substance 6
Range (cm)						
Median (cm)						
Mode (cm)						
Mean (cm)						

Answer the following questions using the class data.

Were there any mystery substances that produced larger bubbles than others?

_____

Were there any mystery substances that produced smaller bubbles than others?

_____

Did adding a larger producing mystery substance guarantee producing a larger bubble? Explain.

_____

_____

_____

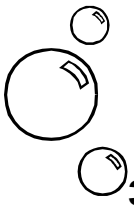
_____

_____

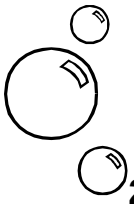
Student Resource Sheet # 5

Teacher Resource Sheet # 3

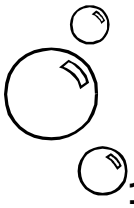
Rubric for Bar Graph



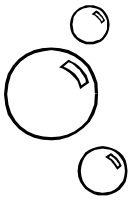
3 Points — **Graph Title**
Appropriate Scale
X and Y Axis Labeled
Accurate Data



2 Points — **3 of the elements listed are correct.**



1 Point — **2 of the elements listed are correct.**



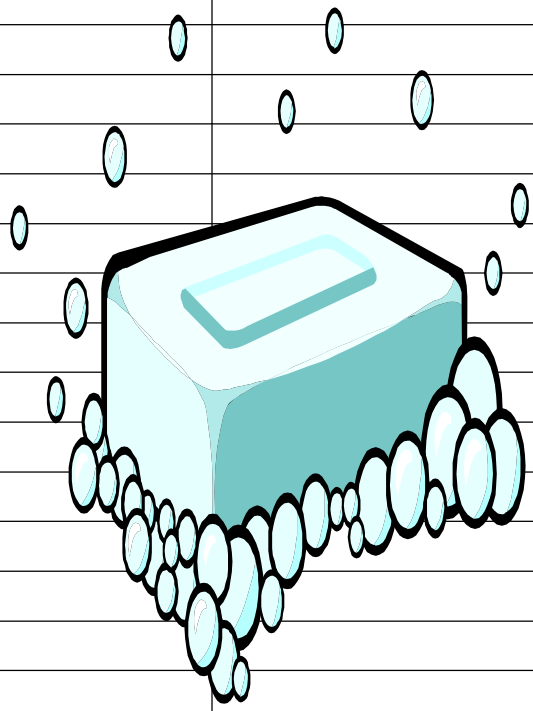
0 Points — **Less than 2 of the elements listed are correct.**

Student Resource Sheet # 6

Can We Make Even a Bigger Bubble?

Brands of Soap

Number of Trials	Diameter (cm)
Trial 1	
Trial 2	
Trial 3	
Trial 4	
Trial 5	
Trial 6	
Trial 7	
Trial 8	
Trial 9	
Trial 10	
Trial 11	
Trial 12	
Trial 13	
Trial 14	
Trial 15	
Trial 16	
Trial 17	
Trial 18	
Trial 19	
Trial 20	
Trial 21	
Trial 22	
Trial 23	
Trial 24	
Trial 25	



Line Plot
Box and Whisker Plot

Range:_____
Median:_____
Mode:_____
Mean:_____

Upper Quartile:_____
Lower Quartile:_____
Upper Extreme:_____
Lower Extreme:_____

Student Resource Sheet # 8

Data Collection for All Brands of Soap

Measures	Brand	Brand	Brand	Brand	Brand	Brand
Range (cm)						
Median (cm)						
Mode (cm)						
Mean (cm)						

Using the class data, write a paragraph about the data collection. Be sure to include data from the chart. Make a prediction about which brand of soap made the largest bubble. Be sure to use math terminology.

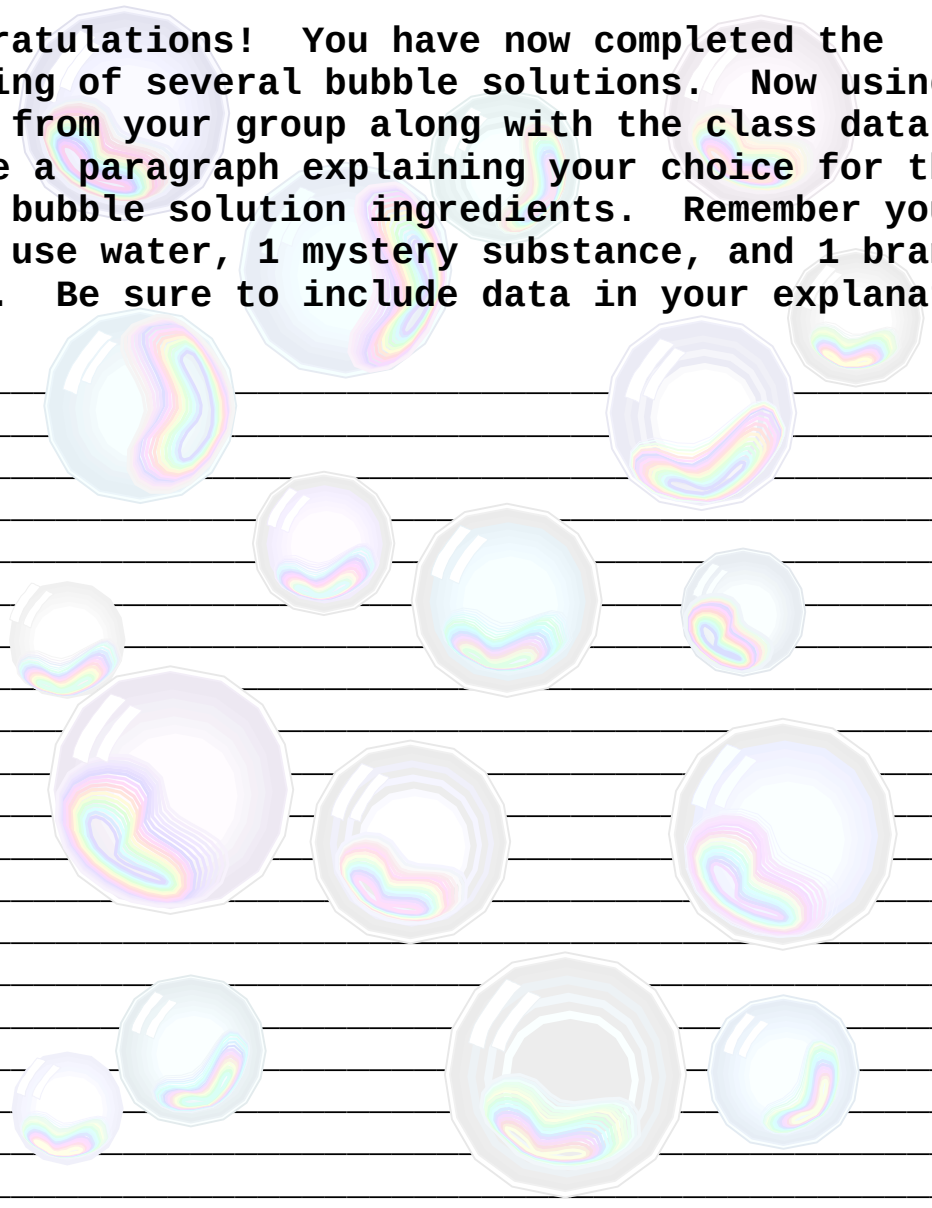
Teacher Resource Sheet # 4

Rubric for Box Plot

Student Resource Sheet # 9

Prize Winning Bubble Solution

Congratulations! You have now completed the testing of several bubble solutions. Now using the data from your group along with the class data, write a paragraph explaining your choice for the best bubble solution ingredients. Remember you may only use water, 1 mystery substance, and 1 brand of soap. Be sure to include data in your explanation.



Teacher Resource Sheet # 5

Rubric for Explanation Rubric

3 points

Student will clearly answer the question using supporting evidence and math terminology in a clear and concise manner.

2 Points

Student will answer with some supporting evidence and some terminology.

1 Point

Student does not cite supporting evidence or is unable to communicate understanding.