

TITLE: Bouncing Balls

GRADE: Grade 7

**CONNECTIONS OF
LESSON TO SMART
CONCEPTS AND OHIO
STANDARDS:**

SMART Concept:

**State of Ohio Academic
Content Standard:**

Data Analysis and Probability
Standard
Patterns, Functions and Algebra
Standard

Benchmark:

- Recognize whether an estimate or an exact solution is appropriate for a given problem situation. Read, create and use line graphs, histograms, circle graphs, box-and-whisker plots, stem-and-leaf plots, and other representations when appropriate.
- Communicate mathematical thinking to others and analyze the mathematical thinking and strategies of others. Collect, organize, display and interpret data for a specific purpose or need.
- Recognize and use mathematical language and symbols when reading, writing and conversing with others. Collect, organize, display and interpret data for a specific purpose or need.

Grade Level Indicator:

7A10 Analyze linear and simple nonlinear relationships to explain how a change in one variable results in the change of another

7A11 Use graphing calculators or computers to analyze change; e.g., distance-time relationships

**Mathematical Processes Standard
Benchmark:**

Source:

NCTM Illuminations
SMART Consortium-MIGG

Common Misconceptions and/or Errors:

- *Students may believe the points of a graph should be connected. (The number of bounces is discrete data; therefore the points should not be connected.)
- *Students may not be able to determine dependent and independent variables.
- *Students may indiscriminately plot points without understanding that "time" is always plotted along the horizontal axis.
- *You may have to remind students to use a "best fit" model to plot the data that is not given in whole number format.

Lesson Summary:

Students will learn how to collect and record data using the motions of a bouncing ball. Data collected will be used to determine the dependent and independent variables in the exercise.

Estimated Time duration:

40 - 80 minutes

Materials/Equipment Needed:

Teacher:

Overhead projector
Graphing grid on overhead slide

Student:

A clock or watch with a second hand
A tennis ball, super ball, baseball, golf ball, ping pong ball, basketball
An activity sheet (see appendix)
Centimeter graph paper
A spreadsheet program or graphing calculator for use in an extension activity
Possible use of motion detector apparatus

Pre-Assessment:

Pre-Assessment Scoring Rubric:

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Have students draw and label a

graph using the following data:

1 tricycle - 3 wheels

2 tricycles - 6 wheels, etc.

Graph data for up to 10 tricycles

with appropriate number of

wheels

3 - Student correctly collects data, creates a table, draws and labels the axes of a graph and displays the data on the graph

2 - Student has 3 out of the four required elements

1 - Student has 1 or 2 out of four required elements

0 - Student has none of the required elements

Post-Assessment:

Post-Assessment Scoring Rubric:

Have students collect and record data by bouncing balls of various sizes and consistencies. They should then construct appropriate graphs illustrating the data, and identify the variables involved. Groups or individual students could present their information to class and lead a discussion comparing the data to the class generated data.

3 - Student accurately records data, plots the data on a graph, and identifies the variables used in the experiment.

2 - Student has two of the three required elements completed.

1 - Student has one of the three required elements completed.

0 - Student is unable to complete any of the three required elements.

Key Vocabulary:

independent variable - a letter used to represent a quantity that varies on its own

dependent variable - a letter used to represent a quantity that varies in proportion to the value of another variable

scale - the ratio of the size of a representation of an object to the actual size of the object

x-axis - the horizontal axis on a coordinate graph; runs right and left through (0,0)

y-axis - the vertical axis on a coordinate graph; runs up and down through (0,0)

Steps for Instruction:

Go to: <http://illuminations.nctm.org/lessonplans/6-8/bouncing/index.html>

Note:

a) The student bouncing the ball must LISTEN carefully to the recorder, but will be expected to continue to bounce the ball until instructed to stop by the time keeper who will give a nonverbal signal to stop bouncing the ball.

b) The student COUNTING the bounces of the ball should count every bounce out loud so all can hear, especially the student recorder.

c) The student RECORDING the data needs to keep track of the number of times the ball bounces.

d) The student KEEPING TIME needs to be sure to give the student bouncing the ball a NONVERBAL cue to stop bouncing the ball so as not to confuse the counter or recorder.

e) Each student will ROTATE jobs so that the group may produce four different tables and graphs.

Differentiated Instruction:

Intervention:

* Give students in need of assistance a specific set of related rate data in chart form and have them plot the data on a graph.

* Give students a specific set of related rate data so that they must create the appropriate value table/chart and plot the data on a graph.

Enrichment:

* Right or Left Handed lesson on the website

* Hand squeeze lesson on the website

* Have students chart data on a wall using an erasable marker, pen or pencil. They are to mark the wall where the ball hits after each bounce off the floor. Have them begin by marking the first bounce as the ball returns up after dropping it the first time. Now let the ball continue to bounce on its own, marking the height of each consecutive bounce on the wall as the ball returns from hitting the floor. The student should not interfere with the natural bounce of the ball.

* Use a graphing calculator or spreadsheet program to record the data and plot a graph.

Advanced students might generate the bouncing ball itself in visual form.

Extensions:

* See links for "internet extensions" on website.

Homework Suggestions and Home Connections:

* Students can conduct an experiment at home using a different surface (concrete, carpet) or a different type ball, graph the data collected, compare the data from the two experiments and brainstorm why they differ or are alike.

Interdisciplinary Connection:

* Have students find graphs in their science textbooks or generated in science class that demonstrate the use of "related rate" in real world situations. One example might be to record the

speed of an airplane with the corresponding number of miles covered by the flight.

* Have students relate the information they learned to Home Economics where they are inviting a large number of guests to a dinner party, and must determine how to amplify the given recipes to make enough food for the number of people attending. (EX: if a recipe generates food for four, but you have invited 36 people, how many times will you need to multiply the quantity of each ingredient to make enough for everyone. Conversely, if the recipe makes enough for 100 people, but you only need food for 40, how will you determine what quantity of each item to put into the mix?)

* Have students generate a list of relationships involving two quantities where change in one quantity will cause a change in the other.

* Have students work with scale drawings and maps to note the relationships between the "scale" and the real drawing. This is a connection to art and social studies.

Technology Connection:

* Students can use a graphing calculator or spreadsheet program to display data, or to generate the next "term".

* Students can use a motion detector to directly enter data into a computer/graphing calculator if one is available. (Motion sensor II for CBL device that ties into graphing calculator available from PASCO. Visit <http://education.ti.com/us/resources/borrow/borrow.html> to find out what is available for loan to a teacher.)

* Additional graph work using time, from "The Mathematics Teacher" September 1994

General Tips:

Appendix:



[Bouncing Balls.pdf](#)