

Math with Toys

Blount County Schools - 1st Annual Math Conference - Friday, May 28, 2010

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Session Description

Participate in standards-based, mathematics activities with “toys,” including paper airplanes, cars, dowel caps, seesaws, dice, etc., with an emphasis on active learning through data collection.

Toys/Activities (Grades 3 through 8)

Playing Cards – *Salute*
 Dice (number cubes) – *Shape Island Mission*
 Dowel Cap (wooden ball/super ball) – *Plot 10 Points*
 Poppers (Eye Poppers) – *Jumping Poppers*
 No. 6 Plastic or commercial kit – *Shrinky Dinks*
 Stacking Toy – *Tower of Hanoi*
 Paper Airplanes/Flying Disks – *How Far Will It Fly?*
 Seesaw (with pop cubes) – *Balancing Animals*
 Lever – *How to Lift a Lion*
 Tops – *Spinning Tops*
 Cars – *Slope of a Line*
 Beads – *Making a Pi Necklace*
 Beads – *Solar System Distance Necklace*

Standards References

National Council of Teachers of Mathematics. (2000). *Principles and standards for school mathematics*. Reston, VA: Author. (See <http://standards.nctm.org/>.)

Tennessee Department of Education. (n.d.). *Curriculum standards, mathematics*. Retrieved from <http://state.tn.us/education/ci/math/index.shtml>

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Web page for session: <http://oneweb.utc.edu/~deborah-mcallister/BlountToys2010.pdf>

Salute

One general and two privates are needed for this game. Each private has half of a deck of cards, using 1 (ace) through 10. When the general says, “salute,” each private deals one card away from the deck and holds it face-up on his or her forehead. The general computes and states the product of the two numbers (positive only). Each private must find the value of the card on his or her forehead. After all cards are played, the student who has the most cards wins the game.

Variations

- ❖ Use integers (black is positive, red is negative).
- ❖ The jack, queen, and king cards can be counted as 11, 12, and 13, respectively, or removed from the deck.

Tennessee Mathematics Standards, Standard 1, Mathematical Processes

SPI 0606.1.3 Use concrete, pictorial, and symbolic representation for integers.

Tennessee Mathematics Standards, Standard 2, Number and Operations

SPI 0306.2.5 Identify various representations of multiplication and division.

SPI 0306.2.6 Recall basic multiplication facts through 10 times 10 and the related division facts.

SPI 0306.2.7 Compute multiplication problems that involve multiples of ten using basic number facts.

SPI 0306.2.8 Solve problems that involve the inverse relationship between multiplication and division.

SPI 0406.2.10 Solve contextual problems using whole numbers, fractions, and decimals.

SPI 0406.2.11 Solve problems using whole number multi-digit multiplication.

SPI 0406.2.12 Solve problems using whole number division with one- or two-digit divisors.

SPI 0706.2.5 Solve contextual problems that involve operations with integers.

Tennessee Mathematics Standards, Standard 3, Algebra

SPI 0306.3.3 Find the missing values in simple multiplication and division equations.

Shape Island Mission

An organism from Shape Island has escaped from its cage! You were the last person to see it. It is up to you to draw the organism, in detail, and state its scientific name. Using number cubes, find the number of sides/angles of the body, the size of the body, the number of antennae, the number of feet, the number of mouths, and the number of tails. Draw and name the organism.

Use the following chart to find the name of the organism (assume the organism has two eyes):

Greek/Latin root, prefix, or suffix	Meaning	Color of Number Cube	Number(s) on Number Cube
anklo/anklos	angle	(red)	
antenna/antennae	external sense organ	(green)	
mono-	one	green, clear, yellow, white	1, 3, 5
bi-	two	green, clear, yellow, white	2, 4, 6
tri-	three	red	3
quad-/quadra	four	red	4
pent-/penta-	five	red	5
hex-/hexa-	six	red	6
cyclo-	circle	red	1, 2
macro-	large	blue	4, 5, 6
micro-	small	blue	1, 2, 3
plast	body	(use with macro-/micro-)	
pod/poda	foot	(yellow)	
stoma	mouth	(clear)	
uro	tail	(white)	
peri-	all around	(not used)	

Samples

Number Cube	Red	Clear	Yellow	Green	Blue	White
Value	1	4	3	2	6	5
Root/Prefix/Suffix	cyclo-	bi-	mono-	bi-	macro-	mono-
Meaning	circle for a body	2 mouths	1 foot	2 antennae	large body	1 tail

Name: Bi-antennae, bi-stoma, mono-uro, mono-poda, macro-cyclo-plast.

Number Cube	Red	Clear	Yellow	Green	Blue	White
Value	4	1	4	1	2	4
Root/Prefix/Suffix	quadrangolo-	mono-	bi-	mono-	micro-	bi-
Meaning	4-sided body	1 mouth	2 feet	1 antenna	small body	2 tails

Name: Mono-antennae, mono-stoma, bi-uro, bi-poda, micro-quadrangolo-plast.

(Modified from Annie Blanks, Ringgold Middle School.)

See Holt, Rinehart, and Winston. (n.d.). *Shape Island*. Retrieved from <http://www.btcsmn.org/StockB/ShapeIsland.pdf>

Data Sheet

Number Cube	Red	Clear	Yellow	Green	Blue	White
Value						
Root/Prefix/Suffix						
Meaning						

Name:

Number Cube	Red	Clear	Yellow	Green	Blue	White
Value						
Root/Prefix/Suffix						
Meaning						

Name:

Number Cube	Red	Clear	Yellow	Green	Blue	White
Value						
Root/Prefix/Suffix						
Meaning						

Name:

Number Cube	Red	Clear	Yellow	Green	Blue	White
Value						
Root/Prefix/Suffix						
Meaning						

Name:

Tennessee Mathematics Standards, Standard 1, Mathematical Processes

SPI 0306.1.6 Identify and use vocabulary to describe attributes of two- and three-dimensional shapes.

SPI 0606.1.1 Make conjectures and predictions based on data.

Tennessee Mathematics Standards, Standard 4, Geometry and Measurement

SPI 0306.4.1 Recognize polygons and be able to identify examples based on geometric definitions.

Tennessee Mathematics Standards, Standard 5, Data Analysis, Statistics, and Probability

SPI 0306.5.3 Make predictions based on various representations of data.

SPI 0406.5.4 List all possible outcomes of a given situation or event.

SPI 0606.5.1 Determine the theoretical probability of simple and compound events in familiar contexts.

SPI 0706.5.4 Use theoretical probability to make predictions.

SPI 0806.5.1 Calculate probabilities of events for simple experiments with equally probable outcomes.

Plot 10 Points

Draw and label a coordinate plane on a piece of graph paper (half-inch or other). Place a piece of carbon paper over the graph paper, with the “carbon” side down. Place a piece of plain paper over the carbon paper. Fasten the papers with a paper clip, and place them on the floor, with the plain paper on top. Drop a dowel cap onto the paper, from the height of your nose. Repeat, for a total of 10 drops. Unfasten the papers. For each point that was plotted, write its coordinates, to the nearest unit. (Re-plot the point to the nearest unit.)

1. What is the distance between the two points that appear to be furthest from each other? (Use the distance formula or the Pythagorean formula, as needed.) For younger grades: Locate two points on the same horizontal or vertical line. Find the distance between the two points.
2. Connect as many points, as possible, to form a polygon. Identify acute, right, and obtuse angles.
3. Estimate the area of the polygon.
4. Estimate the perimeter of the polygon.
5. Determine the slope of one side of the polygon.

Variations

- ❖ Use Quadrant I only for younger grades.

Tennessee Mathematics Standards, Standard 3, Algebra

SPI 0606.3.9 Graph ordered pairs of integers in all four quadrants of the Cartesian coordinate system.

SPI 0806.3.5 Determine the slope of a line from an equation, two given points, a table or a graph.

Tennessee Mathematics Standards, Standard 4, Geometry and Measurement

SPI 0306.4.6 Measure length to the nearest centimeter or half inch.

SPI 0406.4.2 Graph and interpret points with whole number or letter coordinates on grids or in the first quadrant of the coordinate plane.

SPI 0406.4.3 Construct geometric figures with vertices at points on a coordinate grid.

SPI 0406.4.4 Identify acute, obtuse, and right angles in 2-dimensional shapes.

SPI 0506.4.2 Decompose irregular shapes to find perimeter and area.

SPI 0506.4.5 Find the length of vertical or horizontal line segments in the first quadrant of the coordinate system, including problems that require the use of fractions and decimals.

SPI 0806.4.1 Use the Pythagorean Theorem to solve contextual problems.

SPI 0806.4.2 Apply the Pythagorean theorem to find distances between points in the coordinate plane to measure lengths and analyze polygons and polyhedra.

Jumping Poppers

Turn the popper inside-out. It will jump... but when, and how high? Let's collect some data:

	Time until Jump (s)			Height of Jump (cm)		
	Trial 1	Trial 2	Trial 3	Trial 1	Trial 2	Trial 3
"Rim" at bottom						
"Belly" at bottom						

Variations

- ❖ What other conditions could be varied?
- ❖ Draw a bar graph to represent one set of data.
- ❖ Calculate the mean, median, and mode of the class data.
- ❖ Convert from centimeters to meters, or centimeters to millimeters.
- ❖ Convert from metric to U.S. Customary units (e.g., centimeters to inches).

Tennessee Mathematics Standards, Standard 1, Mathematical Processes

SPI 0306.1.7 Select appropriate units and tools to solve problems involving measures.

SPI 0306.1.8 Express answers clearly in verbal, numerical, or graphical (bar and picture) form, using units when appropriate.

SPI 0606.1.1 Make conjectures and predictions based on data.

Tennessee Mathematics Standards, Standard 4, Geometry and Measurement

SPI 0306.4.5 Choose reasonable units of measure, estimate common measurements using benchmarks, and use appropriate tools to make measurements.

SPI 0306.4.6 Measure length to the nearest centimeter or half inch.

SPI 0406.4.7 Determine appropriate size of unit of measurement in problem situations involving length, capacity or weight.

SPI 0506.4.6 Record measurements in context to reasonable degree of accuracy using decimals and/or fractions.

SPI 0806.4.4 Convert between and within the U.S. Customary System and the metric system.

Tennessee Mathematics Standards, Standard 5, Data Analysis, Statistics, and Probability

SPI 0306.5.1 Interpret a frequency table, bar graph, pictograph, or line plot.

SPI 0306.5.2 Solve problems in which data is represented in tables or graph.

SPI 0306.5.3 Make predictions based on various representations of data.

SPI 0406.5.1 Depict data using various representations (e.g., tables, pictographs, line graphs, bar graphs).

SPI 0506.5.1 Depict data using various representations, including decimal and/or fractional data.

SPI 0706.5.1 Interpret and employ various graphs and charts to represent data.

SPI 0706.5.2 Select suitable graph types (such as bar graphs, histograms, line graphs, circle graphs, box-and-whisker plots, and stem-and-leaf plots) and use them to create accurate representations of given data.

SPI 0706.5.3 Calculate and interpret the mean, median, upper-quartile, lower-quartile, and interquartile range of a set of data.

Shrinky Dinks

Materials: No. 6 plastic, scissors, paper, pencil, sand paper, colored pencils, hole punch, thread, toaster oven or oven with baking sheet, spatula

Procedure:

- ❑ Preheat the toaster oven and baking sheet to 350 degrees Fahrenheit.
- ❑ Cut a flat surface from no. 6 plastic.
- ❑ Round edges, as desired.
- ❑ Trace the original shape on a piece of paper.
- ❑ Sand one side of the shape.
- ❑ Using colored pencils, draw a design on the sanded side of the shape.
- ❑ Use the hold punch to leave a hole for attaching the shape to another object.
- ❑ Bake the shape for approximately 30 seconds.
- ❑ Use the spatula to place and remove the shape, as well as to encourage the shape to flatten.
- ❑ On paper, trace the new shape inside the original shape.
- ❑ Calculate the ratio or percentage of the new to original length, width, and area.
- ❑ Use the thread as an ornament hanger.

Related Web sites:

The magical world of shrinky dinks – <http://www.shrinkydinks.com/>

DLTK's Printable Shrinky Dink Patterns – <http://www.dltk-kids.com/type/shrinky.htm>

Tennessee Mathematics Standards, Standard 1, Mathematical Processes

SPI 0306.1.6 Identify and use vocabulary to describe attributes of two- and three-dimensional shapes.

SPI 0306.1.7 Select appropriate units and tools to solve problems involving measures.

SPI 0406.1.4 Compare objects with respect to a given geometric or physical attribute and select appropriate measurement instrument.

SPI 0606.1.1 Make conjectures and predictions based on data.

Tennessee Mathematics Standards, Standard 2, Number and Operations

SPI 0406.2.10 Solve contextual problems using whole numbers, fractions, and decimals.

SPI 0606.2.6 Solve problems involving ratios, rates and percents.

SPI 0706.2.6 Express the ratio between two quantities as a percent, and a percent as a ratio or fraction.

SPI 0706.2.7 Use ratios and proportions to solve problems.

Tennessee Mathematics Standards, Standard 3, Algebra

SPI 0706.3.5 Represent proportional relationships with equations, tables and graphs.

Tennessee Mathematics Standards, Standard 4, Geometry and Measurement

SPI 0306.4.6 Measure length to the nearest centimeter or half inch.

SPI 0406.4.7 Determine appropriate size of unit of measurement in problem situations involving length, capacity or weight.

SPI 0406.4.9 Solve problems involving area and/or perimeter of rectangular figures.

SPI 0506.4.6 Record measurements in context to reasonable degree of accuracy using decimals and/or fractions.

SPI 0706.4.3 Apply scale factor to solve problems involving area and volume.

The Tower of Hanoi

The Legend. In an ancient city in India, so the legend goes, monks in a temple have to move a pile of 64 sacred disks from one location to another. The disks are fragile; only one can be carried at a time. A disk may not be placed on top of a smaller, less valuable disk. And, there is only one other location in the temple (besides the original and destination locations) sacred enough that a pile of disks can be placed there. Here's how the game looks with [seven] disks:



So, the monks start moving disks back and forth, between the original pile, the pile at the new location, and the intermediate location, always keeping the piles in order (largest on the bottom, smallest on the top). The legend is that, before the monks make the final move to complete the new pile in the new location, the temple will turn to dust and the world will end. Is there any truth to this legend? (You would need a time reference for moving one disk.)

The Game. There's a game based on this legend. You have a small collection of disks and three piles into which you can put them (in the physical version of this game, you have three posts onto which you can put the disks, which have holes in the center). The disks all start on the leftmost pile, and you want to move them to the rightmost pile, never putting a disk on top of a smaller one. The middle pile is for intermediate storage. How many moves are required? What is the formula?

Web Sites.

Legend from <http://www.math.toronto.edu/mathnet/games/towers.html>

Cut-out: <http://www.lhs.berkeley.edu/java/tower/towerprintout.html>

Graphic from interactive site: <http://chemeng.p.lodz.pl/zylla/games/hanoi5e.html>

Another (similar) legend: <http://www.article19.com/shockwave/toh.htm>

For more information, search for "Tower of Hanoi" at <http://www.google.com/>

Let's collect some data:

Number of Disks	Moves
1	
2	
3	
4	
n	

Tennessee Mathematics Standards, Standard 1, Mathematical Processes

SPI 0706.1.2 Generalize a variety of patterns to a symbolic rule from tables, graphs, or words.

SPI 0706.1.3 Recognize whether information given in a table, graph, or formula suggests a directly proportional, linear, inversely proportional, or other nonlinear relationship.

Tennessee Mathematics Standards, Standard 3, Algebra

SPI 0306.3.2 Express mathematical relationships using number sentences/equations.

SPI 0306.3.4 Describe or extend (including finding missing terms) geometric and numeric patterns.

SPI 0406.3.2 Make generalizations about geometric and numeric patterns.

SPI 0406.3.3 Represent and analyze patterns using words, function tables, and graphs.

SPI 0606.3.3 Write equations that correspond to given situations or represent a given mathematical relationship.

SPI 0606.3.7 Use algebraic expressions and properties to analyze numeric and geometric patterns.

SPI 0706.3.3 Given a table of inputs x and outputs $f(x)$, identify the function rule and continue the pattern.

SPI 0706.3.7 Translate between verbal and symbolic representations of real-world phenomena involving linear equations.

SPI 0806.3.7 Identify, compare and contrast functions as linear or nonlinear.

How Far Will It Fly?

For making a paper airplane, see the following Web site:
<http://www.exploratorium.edu/exploring/paper/airplanes.html>

Continue to the next page for further information:
<http://www.exploratorium.edu/exploring/paper/airplanes2.html>

Nakamura Lock:



1. Fold a sheet of paper in half lengthwise. Unfold so that the crease is 'valley' side up.



2. Fold the top corners down to the center fold.



3. Fold the tip down.



4. Fold about one inch of the tip up; unfold.



5. Fold the top corners down to the center fold so that the corners meet above the fold in the tip. (Note that the top—the nose of the plane—should be blunt.)



6. Fold the tip up. This is the Nakamura lock.



7. Fold the entire plane in half so that the tip is on the outside.



8. Fold the wings down. Trim and fly!

Doherty, P., & Syjuco, S. (n.d.). *Exploratorium, paper airplanes*. Retrieved from
<http://www.exploratorium.edu/exploring/paper/airplanes.html>

Procedure:

1. Fly three trials. Record each distance, in inches, from the starting line to where the nose of the airplane lands.
2. Record the median distance on a sticky note, and place it on the continuum on the board.
3. Find the mean, median, and mode for the student trials.
4. Construct a stem and leaf plot.
5. Construct a box and whiskers plot.

Variations

- ❖ Use the flying disk toy.

Tennessee Mathematics Standards, Standard 1, Mathematical Processes

SPI 0306.1.7 Select appropriate units and tools to solve problems involving measures.

SPI 0306.1.8 Express answers clearly in verbal, numerical, or graphical (bar and picture) form, using units when appropriate.

SPI 0606.1.1 Make conjectures and predictions based on data.

Tennessee Mathematics Standards, Standard 4, Geometry and Measurement

SPI 0306.4.5 Choose reasonable units of measure, estimate common measurements using benchmarks, and use appropriate tools to make measurements.

SPI 0306.4.6 Measure length to the nearest centimeter or half inch.

SPI 0506.4.6 Record measurements in context to reasonable degree of accuracy using decimals and/or fractions.

Tennessee Mathematics Standards, Standard 5, Data Analysis, Statistics, and Probability

SPI 0406.5.3 Given a set of data or a graph, describe the distribution of the data using median, range, or mode.

SPI 0506.5.3 Calculate measures of central tendency to analyze data.

SPI 0706.5.2 Select suitable graph types (such as bar graphs, histograms, line graphs, circle graphs, box-and-whisker plots, and stem-and-leaf plots) and use them to create accurate representations of given data.

SPI 0706.5.3 Calculate and interpret the mean, median, upper-quartile, lower-quartile, and interquartile range of a set of data.

Balancing Animals Using a Pan Balance [or Seesaw]

Balancing Animals Using a Pan Balance (*Equal Shmequal*)

Let each animal be represented by the given number of cubes:

Mouse/M	2
Turtle/T	3
Rabbit/R	4
Bobcat/C	5
Wolf/W	8
Deer/D	12
Bear/B	30

Set up the balances:

$$\begin{array}{|l|} \hline T = 3 \\ \hline 3 \\ \hline \end{array} < \begin{array}{|l|} \hline W = 8 \\ \hline 8 \\ \hline \end{array}$$

$$\begin{array}{|l|} \hline T + D = 3 + 12 \\ \hline 15 \\ \hline \end{array} > \begin{array}{|l|} \hline W = 8 \\ \hline 8 \\ \hline \end{array}$$

$$\begin{array}{|l|} \hline T + D = 3 + 12 \\ \hline 15 \\ \hline \end{array} > \begin{array}{|l|} \hline W + C = 8 + 5 \\ \hline 13 \\ \hline \end{array}$$

$$\begin{array}{|l|} \hline T + D = 3 + 12 \\ \hline 15 \\ \hline \end{array} < \begin{array}{|l|} \hline W + C + R = 8 + 5 + 4 \\ \hline 17 \\ \hline \end{array}$$

$$\begin{array}{|l|} \hline T + D + M = 3 + 12 + 2 \\ \hline 17 \\ \hline \end{array} = \begin{array}{|l|} \hline W + C + R = 8 + 5 + 4 \\ \hline 17 \\ \hline \end{array}$$

$$\begin{array}{|l|} \hline T + D + M = 3 + 12 + 2 \\ \hline 17 \\ \hline \end{array} < \begin{array}{|l|} \hline W + C + R + B = 8 + 5 + 4 + 30 \\ \hline 47 \\ \hline \end{array}$$

$$\begin{array}{|l|} \hline B + M = 30 + 2 \\ \hline 32 \\ \hline \end{array} = \begin{array}{|l|} \hline R + C + W + T + D = 4 + 5 + 8 + 3 + 12 \\ \hline 32 \\ \hline \end{array}$$

Kroll, V., & O'Neill, P. (2005). *Equal shmequal*. Watertown, MA: Charlesbridge.

Tennessee Mathematics Standards, Standard 1, Mathematical Processes

- SPI 0306.1.5 Represent problems mathematically using diagrams, numbers, and symbolic expressions.
- SPI 0406.1.4 Compare objects with respect to a given geometric or physical attribute and select appropriate measurement instrument.
- SPI 0606.1.3 Use concrete, pictorial, and symbolic representation for integers.
- SPI 0606.1.4 Select the representation that models one of the arithmetic properties (commutative, associative, or distributive).
- SPI 0606.1.5 Model algebraic expressions using algebra tiles.

Tennessee Mathematics Standards, Standard 2, Number and Operations

- SPI 0306.2.4 Compare and order numbers up to 10,000 using the words less than, greater than, and equal to, and the symbols $<$, $>$, $=$.
- SPI 0406.2.10 Solve contextual problems using whole numbers, fractions, and decimals.
- SPI 0506.2.7 Recognize equivalent representations for the same number.
- SPI 0506.2.9 Compare whole numbers, decimals and fractions using the symbols $<$, $>$, and $=$.
- SPI 0706.2.1 Simplify numerical expressions involving rational numbers.
- SPI 0706.2.2 Compare rational numbers using appropriate inequality symbols.
- SPI 0706.2.5 Solve contextual problems that involve operations with integers.

Tennessee Mathematics Standards, Standard 3, Algebra

- SPI 0306.3.1 Verify a conclusion using algebraic properties.
- SPI 0306.3.2 Express mathematical relationships using number sentences/equations.
- SPI 0606.3.3 Write equations that correspond to given situations or represent a given mathematical relationship.
- SPI 0606.3.5 Translate between verbal expressions/sentences and algebraic expressions/equations.
- SPI 0706.3.1 Evaluate algebraic expressions involving rational values for coefficients and/or variables.

Tennessee Mathematics Standards, Standard 4, Geometry and Measurement

- SPI 0306.4.7 Solve problems requiring the addition and subtraction of lengths.
- SPI 0406.4.7 Determine appropriate size of unit of measurement in problem situations involving length, capacity or weight.

How to Lift a Lion

Texas Instruments Incorporated. (2000). *Lifting a lion*. Retrieved from <http://education.ti.com/educationportal/activityexchange/Activity.do?aId=5169>

Wells, R. E. (1996). *How do you lift a lion?* Morton Grove, IL: Albert Whitman & Company.

$$\begin{aligned}\text{Work} &= \text{Force} * \text{distance} \\ &= \text{mass} * \text{gravitational acceleration} * \text{distance} \\ &= \text{mass} * 9.81 \text{ m/s}^2 * \text{distance}\end{aligned}$$

Dimensional analysis for work:

$$\begin{aligned}&= \text{kg} * \text{m/s}^2 * \text{m} \\ &= \text{Newton (N)} * \text{m} \\ &= \text{Joule (J)}\end{aligned}$$

To *balance* the lion, work on each side of the fulcrum must be equal, or $\text{Work}_{\text{cl}} = \text{Work}_{\text{cc}}$. When finding the *mass* at a given distance, gravitational acceleration will cancel from each side of the equation. The TI activity uses the terms work, mass, and weight, which are probably confusing for students in grades 4-6.

Data collection won't be exact since (a) the yardstick will require conversion from inches to cm/m, and (b) the animal's center of gravity might not be placed on the end of the yardstick. One pop cube has a mass of approximately 4 grams.

Worksheet

Yardstick – Find the work required to lift the lion with the fulcrum placed the following distances from the lion:

18 inches L-----^-----P

27 inches L-----^-----P

9 inches L-----^-----P

Ruler – Find the work required to lift the lion with the fulcrum placed the following distances from the lion:

6 (or 6.25) inches L-----^-----P

9 (or 9.375) inches L-----^-----P

3 (or 3.125) inches L-----^-----P

Tennessee Mathematics Standards, Standard 1, Mathematical Processes

- SPI 0306.1.5 Represent problems mathematically using diagrams, numbers, and symbolic expressions.
- SPI 0306.1.7 Select appropriate units and tools to solve problems involving measures.
- SPI 0606.1.1 Make conjectures and predictions based on data.
- SPI 0606.1.2 Judge the reasonableness of the results of rational number estimates and/or computations.
- SPI 0606.1.3 Use concrete, pictorial, and symbolic representation for integers.
- SPI 0706.1.3 Recognize whether information given in a table, graph, or formula suggests a directly proportional, linear, inversely proportional, or other nonlinear relationship.

Tennessee Mathematics Standards, Standard 2, Number and Operations

- SPI 0306.2.5 Identify various representations of multiplication and division.
- SPI 0306.2.8 Solve problems that involve the inverse relationship between multiplication and division.
- SPI 0406.2.10 Solve contextual problems using whole numbers, fractions, and decimals.
- SPI 0406.2.11 Solve problems using whole number multi-digit multiplication.
- SPI 0406.2.12 Solve problems using whole number division with one- or two-digit divisors.
- SPI 0506.2.4 Solve problems involving the division of two- and three-digit whole numbers by one- and two-digit whole numbers.
- SPI 0606.2.6 Solve problems involving ratios, rates and percents.
- SPI 0706.2.5 Solve contextual problems that involve operations with integers.
- SPI 0706.2.6 Express the ratio between two quantities as a percent, and a percent as a ratio or fraction.
- SPI 0706.2.7 Use ratios and proportions to solve problems.

Tennessee Mathematics Standards, Standard 3, Algebra

- SPI 0306.3.1 Verify a conclusion using algebraic properties.
- SPI 0306.3.2 Express mathematical relationships using number sentences/equations.
- SPI 0306.3.3 Find the missing values in simple multiplication and division equations.
- SPI 0406.3.1 Use letters and symbols to represent an unknown quantity and write a simple mathematical expression.
- SPI 0606.3.3 Write equations that correspond to given situations or represent a given mathematical relationship.
- SPI 0606.3.5 Translate between verbal expressions/sentences and algebraic expressions/equations.
- SPI 0706.3.5 Represent proportional relationships with equations, tables and graphs.
- SPI 0706.3.7 Translate between verbal and symbolic representations of real-world phenomena involving linear equations.

Tennessee Mathematics Standards, Standard 4, Geometry and Measurement

- SPI 0306.4.5 Choose reasonable units of measure, estimate common measurements using benchmarks, and use appropriate tools to make measurements.
- SPI 0306.4.6 Measure length to the nearest centimeter or half inch.
- SPI 0306.4.7 Solve problems requiring the addition and subtraction of lengths.
- SPI 0406.4.6 Determine situations in which a highly accurate measurement is important.
- SPI 0406.4.7 Determine appropriate size of unit of measurement in problem situations involving length, capacity or weight.
- SPI 0406.4.8 Convert measurements within a single system that are common in daily life (e.g., hours and minutes, inches and feet, centimeters and meters, quarts and gallons, liters and milliliters).

Tennessee Mathematics Standards, Standard 5, Data Analysis, Statistics, and Probability

- SPI 0306.5.2 Solve problems in which data is represented in tables or graph.
- SPI 0306.5.3 Make predictions based on various representations of data.
- SPI 0406.5.1 Depict data using various representations (e.g., tables, pictographs, line graphs, bar graphs).
- SPI 0406.5.2 Solve problems using estimation and comparison within a single set of data.

Spinning Tops

Let's collect some data:

	Time of Spin (s)		
	Trial 1	Trial 2	Trial 3
Small plastic top			
Large plastic top			
Wooden top			

Variations

- ❖ What other conditions could be varied?
- ❖ Draw a bar graph to represent one set of data.
- ❖ Calculate the mean, median, and mode of the class data.
- ❖ Spin the top on a piece of graph paper. Record starting and ending points, and calculate displacement.

Tennessee Mathematics Standards, Standard 1, Mathematical Processes

SPI 0306.1.7 Select appropriate units and tools to solve problems involving measures.

SPI 0306.1.8 Express answers clearly in verbal, numerical, or graphical (bar and picture) form, using units when appropriate.

SPI 0606.1.1 Make conjectures and predictions based on data.

Tennessee Mathematics Standards, Standard 4, Geometry and Measurement

SPI 0306.4.5 Choose reasonable units of measure, estimate common measurements using benchmarks, and use appropriate tools to make measurements.

SPI 0306.4.6 Measure length to the nearest centimeter or half inch.

SPI 0406.4.7 Determine appropriate size of unit of measurement in problem situations involving length, capacity or weight.

SPI 0506.4.6 Record measurements in context to reasonable degree of accuracy using decimals and/or fractions.

Tennessee Mathematics Standards, Standard 5, Data Analysis, Statistics, and Probability

SPI 0306.5.1 Interpret a frequency table, bar graph, pictograph, or line plot.

SPI 0306.5.2 Solve problems in which data is represented in tables or graph.

SPI 0306.5.3 Make predictions based on various representations of data.

SPI 0406.5.1 Depict data using various representations (e.g., tables, pictographs, line graphs, bar graphs).

SPI 0506.5.1 Depict data using various representations, including decimal and/or fractional data.

SPI 0706.5.1 Interpret and employ various graphs and charts to represent data.

SPI 0706.5.2 Select suitable graph types (such as bar graphs, histograms, line graphs, circle graphs, box-and-whisker plots, and stem-and-leaf plots) and use them to create accurate representations of given data.

SPI 0706.5.3 Calculate and interpret the mean, median, upper-quartile, lower-quartile, and interquartile range of a set of data.

Slope of a Line

Materials: Battery-operated car with two speed settings, meter sticks/tape measures, stopwatches, graph/chart paper, paper and pencil.

Procedure:

- Collect data for each of the two speeds.
- Students will be paired along the track, with one as the timer and one as the recorder. Depending on the speed of the car, place students at every 20, 50, or 100 centimeters.
- Start the car with the front bumper at the zero mark.
- When the car begins to move, all stopwatches should begin.
- When the front bumper of the car reaches each recording point, that stopwatch will be stopped, and the time and distance will be recorded.
- Plot data on a coordinate plane, with time (x-axis) versus distance (y-axis).
- Calculate the rate of the car at each speed setting by finding the slope of each line (D/t).

Tennessee Mathematics Standards, Standard 1, Mathematical Processes

- SPI 0306.1.7 Select appropriate units and tools to solve problems involving measures.
- SPI 0306.1.8 Express answers clearly in verbal, numerical, or graphical (bar and picture) form, using units when appropriate.
- SPI 0606.1.1 Make conjectures and predictions based on data.
- SPI 0606.1.2 Judge the reasonableness of the results of rational number estimates and/or computations.
- SPI 0606.1.3 Use concrete, pictorial, and symbolic representation for integers.
- SPI 0706.1.3 Recognize whether information given in a table, graph, or formula suggests a directly proportional, linear, inversely proportional, or other nonlinear relationship.
- SPI 0806.1.1 Solve problems involving rate/time/distance (i.e., $d = rt$).
- SPI 0806.1.2 Interpret a qualitative graph representing a contextual situation.

Tennessee Mathematics Standards, Standard 2, Number and Operations

- SPI 0306.2.5 Identify various representations of multiplication and division.
- SPI 0306.2.11 Recognize and use different interpretations of fractions.
- SPI 0406.2.10 Solve contextual problems using whole numbers, fractions, and decimals.
- SPI 0406.2.12 Solve problems using whole number division with one- or two-digit divisors.
- SPI 0606.2.3 Solve problems involving the addition, subtraction, multiplication, and division of decimals.
- SPI 0606.2.6 Solve problems involving ratios, rates and percents.
- SPI 0706.2.7 Use ratios and proportions to solve problems.

Tennessee Mathematics Standards, Standard 3, Algebra

- SPI 0306.3.1 Verify a conclusion using algebraic properties.
- SPI 0306.3.2 Express mathematical relationships using number sentences/equations.
- SPI 0306.3.3 Find the missing values in simple multiplication and division equations.
- SPI 0406.3.1 Use letters and symbols to represent an unknown quantity and write a simple mathematical expression.
- SPI 0406.3.2 Make generalizations about geometric and numeric patterns.
- SPI 0406.3.3 Represent and analyze patterns using words, function tables, and graphs.
- SPI 0506.3.3 Find the unknown in single-step equations involving fractions and mixed numbers.

- SPI 0606.3.3 Write equations that correspond to given situations or represent a given mathematical relationship.
- SPI 0606.3.4 Rewrite expressions to represent quantities in different ways.
- SPI 0606.3.5 Translate between verbal expressions/sentences and algebraic expressions/equations.
- SPI 0706.3.3 Given a table of inputs x and outputs $f(x)$, identify the function rule and continue the pattern.
- SPI 0706.3.4 Interpret the slope of a line as a unit rate given the graph of a proportional relationship.
- SPI 0706.3.5 Represent proportional relationships with equations, tables and graphs.
- SPI 0706.3.7 Translate between verbal and symbolic representations of real-world phenomena involving linear equations.
- SPI 0806.3.5 Determine the slope of a line from an equation, two given points, a table or a graph.
- SPI 0806.3.6 Analyze the graph of a linear function to find solutions and intercepts.

Tennessee Mathematics Standards, Standard 4, Geometry and Measurement

- SPI 0306.4.5 Choose reasonable units of measure, estimate common measurements using benchmarks, and use appropriate tools to make measurements.
- SPI 0306.4.6 Measure length to the nearest centimeter or half inch.
- SPI 0406.4.6 Determine situations in which a highly accurate measurement is important.
- SPI 0406.4.7 Determine appropriate size of unit of measurement in problem situations involving length, capacity or weight.
- SPI 0406.4.8 Convert measurements within a single system that are common in daily life (e.g., hours and minutes, inches and feet, centimeters and meters, quarts and gallons, liters and milliliters).
- SPI 0506.4.6 Record measurements in context to reasonable degree of accuracy using decimals and/or fractions.

Tennessee Mathematics Standards, Standard 5, Data Analysis, Statistics, and Probability

- SPI 0306.5.1 Interpret a frequency table, bar graph, pictograph, or line plot.
- SPI 0306.5.2 Solve problems in which data is represented in tables or graph.
- SPI 0306.5.3 Make predictions based on various representations of data.
- SPI 0406.5.1 Depict data using various representations (e.g., tables, pictographs, line graphs, bar graphs).
- SPI 0406.5.2 Solve problems using estimation and comparison within a single set of data.
- SPI 0506.5.1 Depict data using various representations, including decimal and/or fractional data.
- SPI 0706.5.1 Interpret and employ various graphs and charts to represent data.
- SPI 0706.5.2 Select suitable graph types (such as bar graphs, histograms, line graphs, circle graphs, box-and-whisker plots, and stem-and-leaf plots) and use them to create accurate representations of given data.
- SPI 0806.5.3 Generalize the relationship between two sets of data using scatterplots and lines of best fit.

Making a Pi Necklace

by Diana Funke

Mathematics teacher, Davisville Middle School, North Kingstown, RI

As a 7th grade math teacher, I like to make mathematics as visual as possible. For Pi Day, my students make Pi necklaces.

I use Pi as a way of introducing my students to the idea of an irrational number. After studying decimals that terminate or repeat, I ask them to bring in a can and we compare the circumference to the diameter by dividing C by d . This is how they find out what Pi is all about.

I have them make a Pi necklace to reinforce the idea that some numbers never repeat or end. We usually use from 100 to 300 beads, depending on the size of the bead. They assign a color to each digit (including 0) and then string beads of those colors into a necklace, using the digits of Pi as their guide. Some students make their own beads with polymer clay and others string store-bought beads of all sizes. The first bead, representing the number three, is bigger than the rest. (In the illustration, the necklace has a big silver triangular "bead" as the whole number 3 part of Pi.)

At 1:59 P.M. we all stop what we are doing and wish everyone a Happy Pi Day!

Funke, D., & The Math Forum. (2008). *Making a pi necklace*. Retrieved from http://mathforum.org/teachers/middle/activities/pi_day.html

Added by Deborah McAllister

Pi – to 100 Digits

3.1415926535 8979323846 2643383279 5028841971 6939937510
5820974944 5923078164 0628620899 8628034825 3421170679

Digits from Encyclopedia Uselessia - <http://www.greatplay.net/uselessia/articles/pi2-100.html>

Key for Beads

Special beads for 3 and decimal point.

<u>Digit</u>	<u>Bead</u>	<u>Number</u>
0	Black	8
1	Pink	8
2	Violet	12
3	Indigo	11
4	Blue	10
5	Green	8
6	Yellow	9
7	Orange	8
8	Red	12
9	White	14

Tennessee Mathematics Standards, Standard 1, Mathematical Processes

SPI 0306.1.6 Identify and use vocabulary to describe attributes of two- and three-dimensional shapes.

SPI 0306.1.7 Select appropriate units and tools to solve problems involving measures.

SPI 0406.1.4 Compare objects with respect to a given geometric or physical attribute and select appropriate measurement instrument.

SPI 0606.1.1 Make conjectures and predictions based on data.

SPI 0706.1.3 Recognize whether information given in a table, graph, or formula suggests a directly proportional, linear, inversely proportional, or other nonlinear relationship.

Tennessee Mathematics Standards, Standard 2, Number and Operations

SPI 0406.2.10 Solve contextual problems using whole numbers, fractions, and decimals.

SPI 0606.2.3 Solve problems involving the addition, subtraction, multiplication, and division of decimals.

SPI 0606.2.6 Solve problems involving ratios, rates and percents.

SPI 0706.2.7 Use ratios and proportions to solve problems.

Tennessee Mathematics Standards, Standard 3, Algebra

SPI 0606.3.5 Translate between verbal expressions/sentences and algebraic expressions/equations.

SPI 0706.3.5 Represent proportional relationships with equations, tables and graphs.

SPI 0806.3.4 Translate between various representations of a linear function.

SPI 0806.3.5 Determine the slope of a line from an equation, two given points, a table or a graph.

SPI 0806.3.7 Identify, compare and contrast functions as linear or nonlinear.

Tennessee Mathematics Standards, Standard 4, Geometry and Measurement

SPI 0506.4.6 Record measurements in context to reasonable degree of accuracy using decimals and/or fractions.

Tennessee Mathematics Standards, Standard 5, Data Analysis, Statistics, and Probability

SPI 0306.5.3 Make predictions based on various representations of data.

SPI 0506.5.1 Depict data using various representations, including decimal and/or fractional data.

Solar System Distance Necklace

Challenger Learning Center of Maine Education Committee. (2006). *Solar system distance*. Retrieved from <http://www.challenger.org/lessons/85.pdf>

Each bead different than spacing beads represents the sun, a planet, or a dwarf planet (Pluto). I have modified the chart on the last page to include the sun and additional spacing beads. Note: Each spacing bead represents 30-60 million miles.

Knot the string, leaving some length to tie to the other end. Use elastic string.

Sequence of beads:

Sun – large yellow

1 spacing bead

Inner Planets

Mercury – small yellow

1 spacing bead

Venus – small green

1 spacing bead

Earth – small blue

1 spacing bead

Mars – small red

6 spacing beads

Outer Planets

Jupiter – large orange/red

7 spacing beads

Saturn – large yellow/orange

15 spacing beads

Uranus – medium green

17 spacing beads

Neptune – medium blue/purple

14 spacing beads

Pluto – small black

Spacing beads, as needed for the length of necklace

Knot the end of the string, leaving some length. Tie the ends of the string to form a necklace.

See <http://solarsystem.nasa.gov/planets/>

The Solar System link has several resources.

Tennessee Mathematics Standards, Standard 1, Mathematical Processes

- SPI 0306.1.7 Select appropriate units and tools to solve problems involving measures.
- SPI 0406.1.4 Compare objects with respect to a given geometric or physical attribute and select appropriate measurement instrument.
- SPI 0606.1.3 Use concrete, pictorial, and symbolic representation for integers.
- SPI 0706.1.4 Use scales to read maps.
- SPI 0806.1.2 Interpret a qualitative graph representing a contextual situation.

Tennessee Mathematics Standards, Standard 2, Number and Operations

- SPI 0606.2.7 Locate positive rational numbers on the number line.
- SPI 0706.2.7 Use ratios and proportions to solve problems.
- SPI 0806.2.4 Solve real-world problems requiring scientific notation.

Tennessee Mathematics Standards, Standard 3, Algebra

- SPI 0706.3.5 Represent proportional relationships with equations, tables and graphs.

Tennessee Mathematics Standards, Standard 4, Geometry and Measurement

- SPI 0306.4.5 Choose reasonable units of measure, estimate common measurements using benchmarks, and use appropriate tools to make measurements.
- SPI 0406.4.6 Determine situations in which a highly accurate measurement is important.
- SPI 0406.4.7 Determine appropriate size of unit of measurement in problem situations involving length, capacity or weight.
- SPI 0806.4.4 Convert between and within the U.S. Customary System and the metric system.

Tennessee Mathematics Standards, Standard 5, Data Analysis, Statistics, and Probability

- SPI 0406.5.2 Solve problems using estimation and comparison within a single set of data.
- SPI 0706.5.1 Interpret and employ various graphs and charts to represent data.