



Tools for Active Teaching and Active Learning

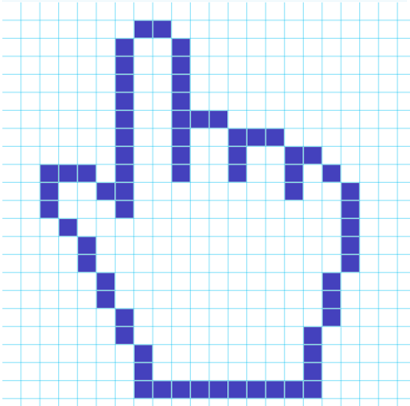
Hands-On Math

Graph Cubes



- ★ Introduction to Graphing Concepts
- ★ Individual and Group Activities
- ★ Student-Centered Learning
- ★ An Interactive Way to Explore Data

Instructor's Guide



Ventura Educational Systems

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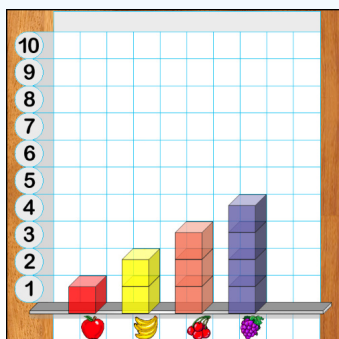
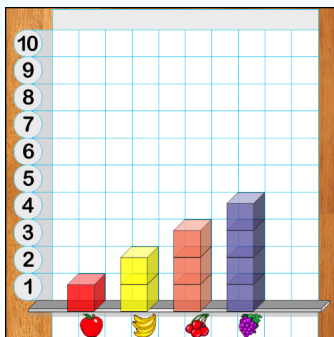


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Overview

Hand-on Math Graph Cubes is a great way to introduce students to data analysis. In elementary math education it is critically important that students see the relevance of what they are learning. Math needs to make sense. The Hands-On Math Graph Cubes helps students learn to analyze and describe data presented in charts and graphs.

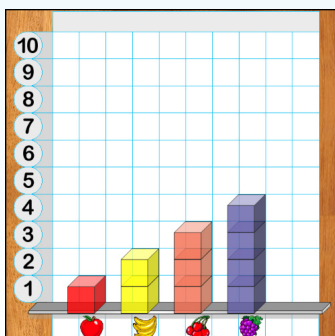
Research has shown that children learn best through active involvement in the learning process. Hands-On Math Graph Cubes is designed to be a tool that teachers can use for active teaching and active learning. Math manipulative devices can be a rich source of teaching strategies for problem solving and can be very helpful in developing an intuitive understanding of mathematical concepts. The Hands-On Math series suggests ways in which concrete learning experiences can be extended to a representational level and still remain manipulative and interactive.

This guide consists of two sections. The first part is written for the teacher and explains the functions of the app and options available. It presents ideas for instructional strategies that can be implemented with each simulated manipulative device. The second section of the manual is a set of curriculum-based activities that are designed to help the teacher in using the Hands-On Math app. These activities have been developed for elementary and middle school age children. Teachers will want to decide what is the best sequence for using the materials with their particular group of students. Each lesson is aimed at specific mathematical objectives including counting, representing data through graphs and tables, surveys, using tally marks, comparing integers, addition and subtraction. Each activity is meant to be a beginning. Teachers will want to encourage the children to explore extensions of each activity with different examples. Orally discussing each activity will help to foster higher level thinking.

Hands-On Math Graph Cubes is a starting point. Learning should be fun and as students work with the app, it is my intention that they will begin discussing, sharing and creatively exploring mathematics.

-- Fred Ventura, Ph.D.

Visualizing mathematical concepts is the key to understanding. Models help significantly in cognitive development.



Introduction to Hands-On Math Graph Cubes

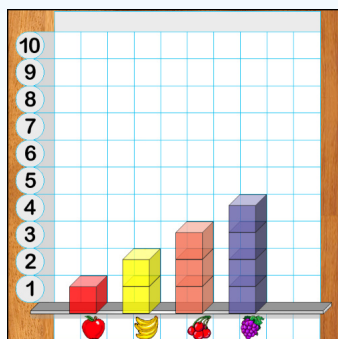
Piaget's theory of cognitive development is a comprehensive theory about the nature and development of human intelligence.

Approaches to the teaching of mathematics that rely heavily on one methodology are inherently weak and unlikely to produce optimal results. Educators have found that teaching strategies must adapt to accommodate new discoveries which expand our understanding of the learning process and new technologies which expand our delivery systems.

According to learning theory, children learn best when they are actively involved in the learning process. There are many ways to do this but one example is having children work in small groups in a laboratory/discovery situation. Small group instruction encourages variation in teaching methodology. Variation in the way in which material is presented serves the instructional process since one particular methodology may not be best for all children. Different children respond differently to a particular educational approach. The same methodology that is appropriate for one content area or developmental stage may not be appropriate in a different content area or with children who are at a different developmental stage.

For learning mathematics an active teaching and active learning situation is a very desirable educational environment. To create it the teacher must be aware of the behavioral characteristics of the students with regard to mathematics, must be knowledgeable in the particular skills which are being taught and must be able to draw upon diverse strategies in order to decide which is the most appropriate for fostering the development of the targeted mathematical concepts.

In general, educational psychologists believe that the ability of children to learn passes through developmental stages. Each stage is characterized by particular behaviors. In the early stages learning is tied to perceptual responses. As the child matures, abstract reasoning becomes possible and concrete models are useful for laying the conceptual groundwork for new ideas, but once a concept has been internalized the concrete models are no longer necessary. The work of Swiss psychologist, Jean Piaget, has contributed a great deal to support this theory, and to foster the development of educational strategies which are consistent with the theory.



Using an iPad in a Manipulative Approach to Math

We use the term “playground” to convey the open-ended, discovery approach to learning that this tool was designed to support.

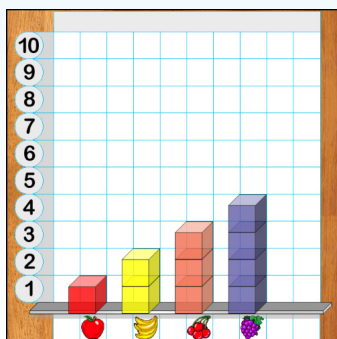
Hands-On Math Graph Cubes combines and extends the use of concrete materials for teaching mathematics to the touch-based interactive environment of the Apple® iPad™. When used in conjunction with actual manipulative devices the app offers a unique set of strategies for active learning. While using the app students can draw upon concepts developed from concrete experiences that were gained using manipulative devices and will work with the same concepts in a more representational manner using the app. In this way the child’s concrete mathematical knowledge is used to help make a transition to a representational stage and serves as a foundation for the development of abstract mathematical thinking skills.

Once mathematical concepts have been internalized by the child in a concrete way, the stage is set for a deeper understanding of the more formal, abstract axioms of higher mathematics.

Hands-On Math Graph Cubes simulates the use of a set of cubes to build bar graphs. While using the cubes students are given feedback so that they can see logical relationships. Visualization is an effective way to help students understand mathematical reasoning and is especially useful in data analysis. A benefit derived from using the Graph Cubes is that the cubes can be easily manipulated and therefore good problem solving strategies spontaneously evolve. The concepts studied in this curriculum are the foundations of mathematical development especially in areas that are a part of the data analysis, probability and discrete mathematics strand. The app provides an interactive Playground where graphs and tables can be created and explored. Student interaction with the device is augmented by the artificially intelligent feedback provided by the software. The instructional approaches that result from creating an open-ended area for free exploration and discovery are exciting. On what we call a Playground students manipulate a supply of virtual cubes to create graphs representing data collected through surveys.

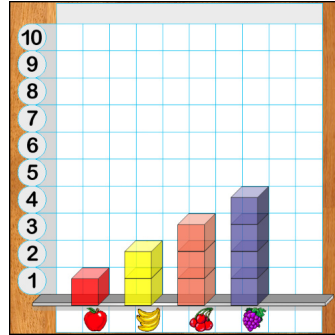
When using Graph Cubes simple gestures are used to drag and drop blocks, placing them in columns to build bar graphs. The author and designer coined the term, “artificially intelligent math manipulative” to describe how using the Hands-On Math apps differs from the concrete manipulative devices traditionally used in classrooms. For example, this app provides intelligent mathematical feedback as the student manipulates the cubes. Immediately associating feedback with a behavior is an effective way to reinforce behavior and facilitate learning.

The Hands-On Math Graph Cubes Playground can also be effectively used with lessons that present mathematical concepts in a structured way. Initially teachers may want to provide ample free exploration time and then after the students have become familiar with the product, direct students into more structured investigations, for example, designing surveys, collecting data and representing the data in a graph. Students will make discoveries and when they do teachers should encourage them to share their discoveries with others in their group.

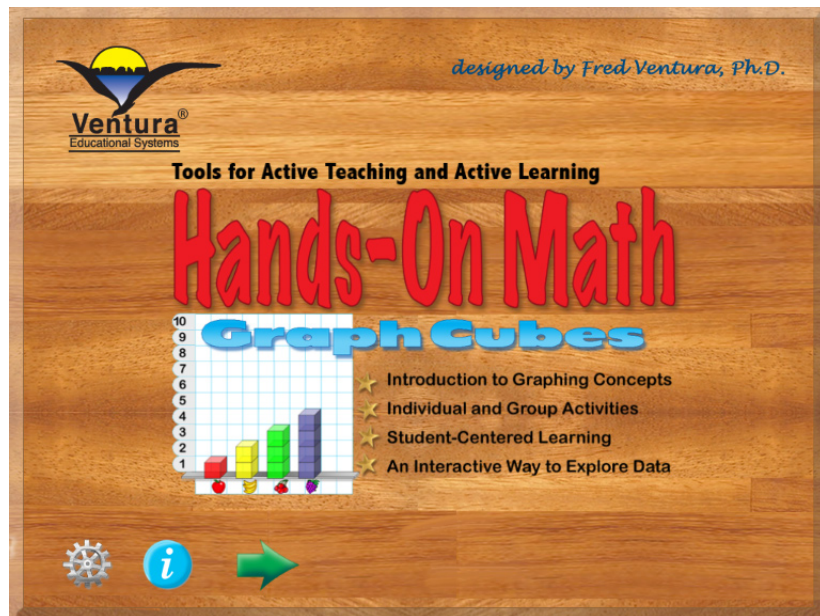


Getting Started

Hands-On Math Graph Cubes helps students develop an understanding of several important mathematical concepts, such as, using tables and graphs to represent data, make comparisons and to analyze the results of surveys. The program is designed in such a way that the physical operation of the app does not interfere with the learning activity. Icons are used to provide the user with complete control over the interaction with the software features.



Tap the Hands-On Math Graph Cubes icon to launch the app.



The opening view presents the title page with three options:



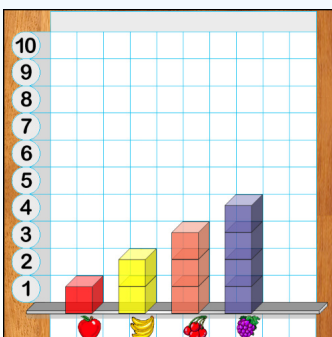
Settings - Tap this icon to control the sound, speech and view options of the app.



Info - Tap this icon to access the User's Guide where an overview of the app is presented.



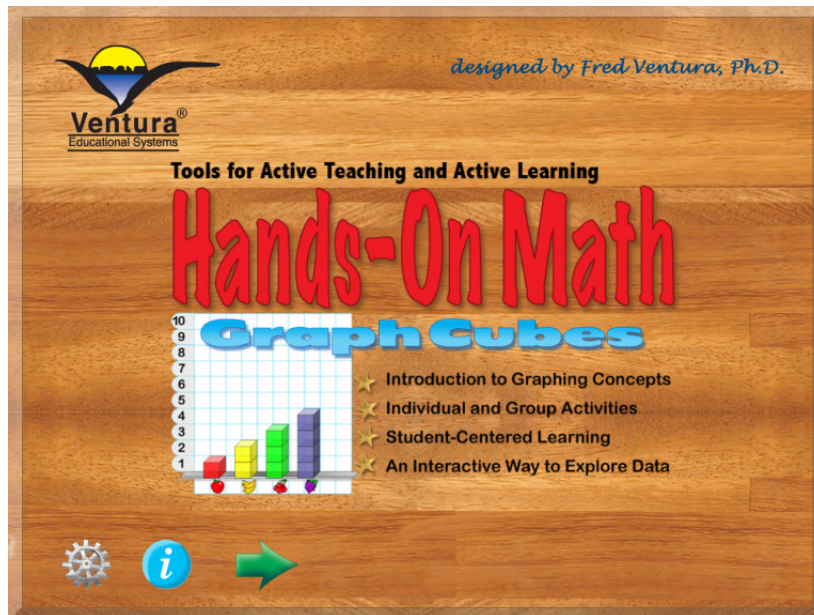
Begin - Tap the green arrow to start using the Hands-On Math Graph Cubes Playground.



Settings

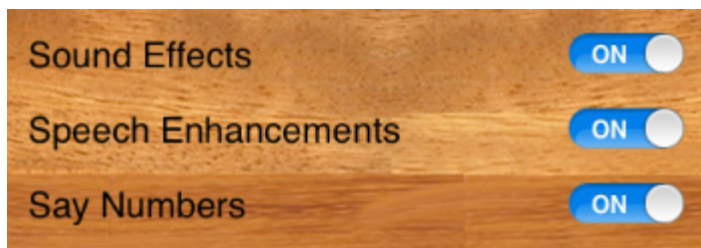


The Settings option provides control of some of the basic features of the app. Options include control for sound effects and speech.

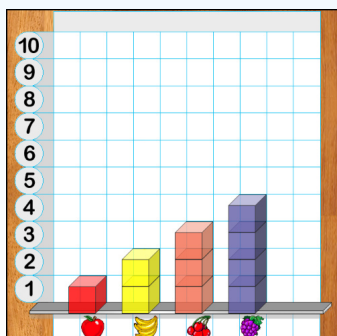


Mild sound effects are used through out the app and add a level of interest for students. When using the app with very young students teachers may wish to have the Speech option on. When Speech is 'on' the numbers and colors.

Use Speech effects with very young children to reinforce the names of the numbers.

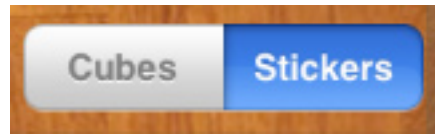


Use the on/off switch to activate or deactivate the sound effects and speech.



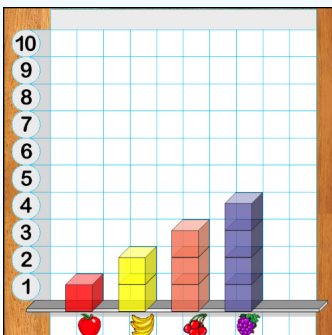
Stickers and Cubes

Stickers are used to label the columns of the graph. The stickers are organized in groups but stickers from any group can be used in creating a graph. Tap 'Stickers' on the segmented control to display a set of stickers.



Stickers are used to label the columns of the graph. The stickers are organized in groups but stickers from any group can be used in creating a graph.

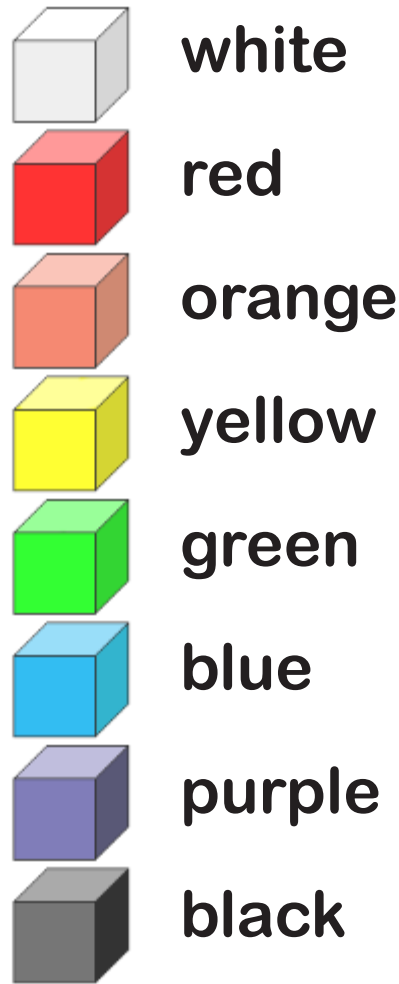
| | |
|-----------------|--|
| Fruit | |
| Colors | |
| Shapes | |
| Pets | |
| Days | Day Mon Tue Wed Thu Fri Sat Sun |
| Feelings | |
| Eye/Hair | |
| Sports | |
| Weather | |
| Holidays | |



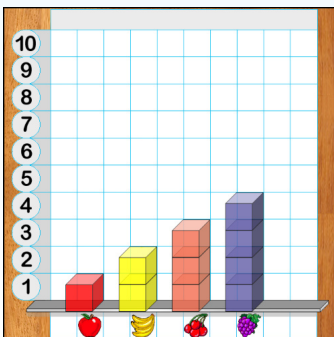
Tap the arrow buttons to switch sticker sets.

Stickers and Cubes

Hands-On Math Graph Cubes provides 8 cubes as virtual math manipulatives for students to use in creating graphs. Cubes are placed on the graph by dragging and dropping them on a column. The first cube placed in any column determines the color for the column. Columns can only contain one color of cubes. If a cube that is a different color is placed on a column that already contains cubes, the cube disappears.



When the speech enhancements setting is on, the color associated with each cube is spoken when it is touched. As cubes are placed on the graph, the number of each cubes in the column is spoken.



In App User's Guide



Tapping the Info icon brings up the Hands-On Math User's Guide. The guide provides a quick overview to the features of the app. It serves as a quick reference to the use of the product.



Users can navigate by tapping either the right or left arrows. Swiping right or left can also be used to move to the next page or previous page.

Exit the user's guide by tapping the home icon.

Swipe right or left to change pages or use the buttons.



Next Page - Tap this icon to move to the next page.



Previous Page - Tap this icon to move to the next page.



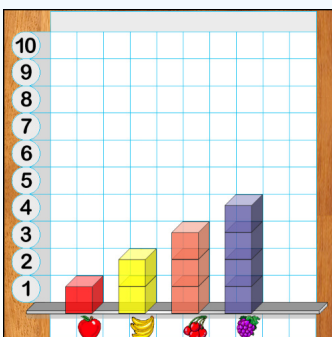
Instructor's Guide - Tap to automatically begin downloading the PDF of the Instructor's Guide from www.venturaes.com. We recommend you install the Instructor's Guide in iBooks for convenient reference.



Tap the World Wide Web icon to launch your iPad browser and view the Ventura Educational Systems website.



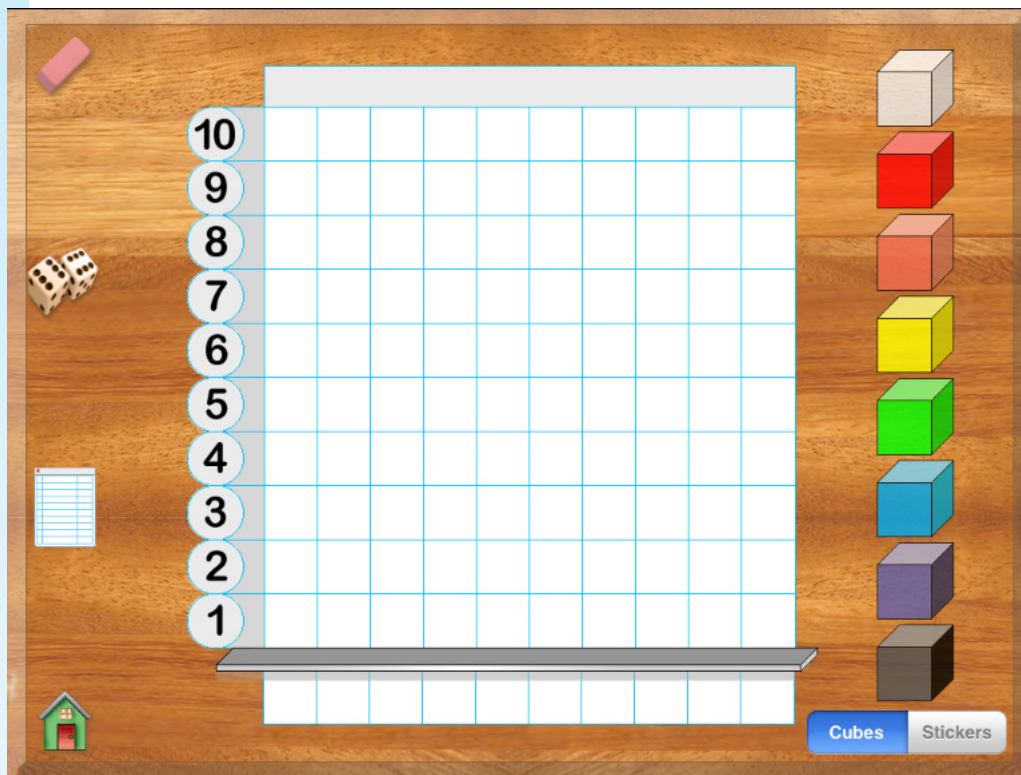
Home - Tap this icon to exit from the User's Guide.



The Graph Cubes Playground



Launch the Graph Cubes Playground and let the fun begin. Tap the green arrow to get started. You will notice that in addition to the grid there is a row of cubes at the bottom of the screen in portrait mode or on the right side of the screen in landscape mode. In addition there is a segmented control with two options: cubes or stickers.

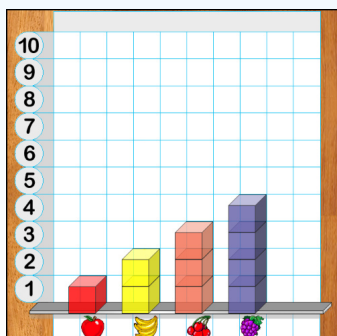


Gesture for Placing a Cube on the Playground: Touch the center of the red cube and while holding your finger down drag the cube to the first column of the graph. When you release your finger, the cube drops to the bottom of the column.

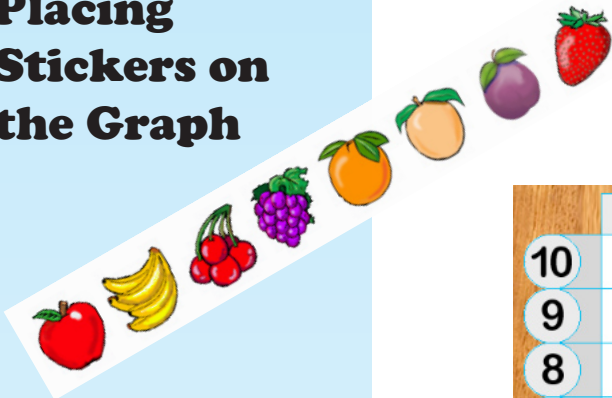
To remove a cube from the grid drag and drop it anywhere outside the perimeter of the grid.

Notice that cubes can be freely added or removed from the graph by dragging and dropping. However, columns on the grid can only contain one color of cube, so if a column is blank any color cube can be placed in the column. But if a column has one or more cubes in it then only cubes of the same color can be placed in that column.

Place 3 red cubes in the first column, 5 yellow cubes in the third column and 4 orange cubes in the fifth column to start building a graph.

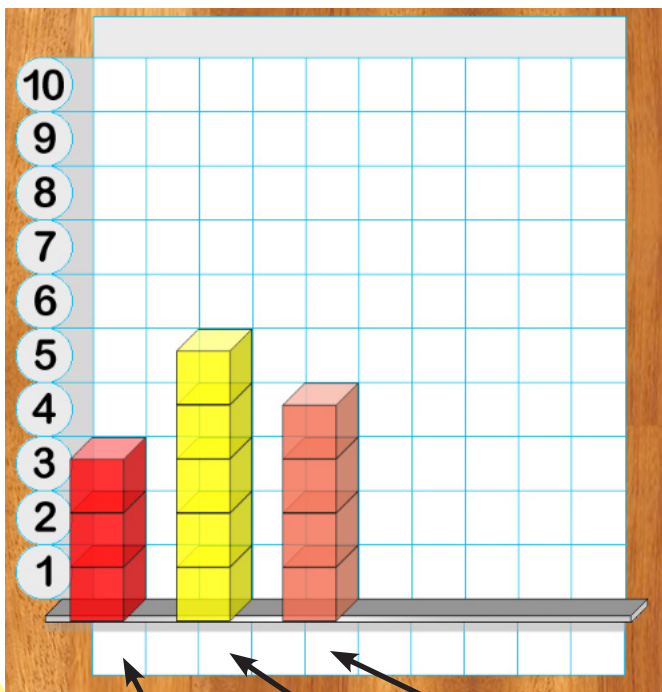


Placing Stickers on the Graph



The graph shows 3 red cubes in the first column, 5 yellow cubes in the third column and 4 orange cubes in the fifth column.

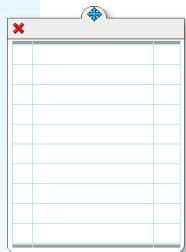
Tap the 'Stickers' option on the segmented control to display a set of stickers. The first set to be displayed is a collection of fruit icons. The red arrows are used to switch from one set to another.



Change settings at any time by navigating to the Settings screen.



Icons



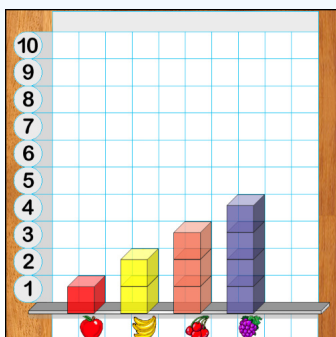
Drag the apple icon to the first column to label it. Drag the banana to the third column and the orange to the fifth column.

Tap the table icon to show the table. Notice that a table that corresponds to the graph has automatically been created.

Tap the eraser icon to erase the graph and clear the table.

Tap the dice icon to randomly generate a graph.

| | | |
|--|--------|---|
| | Apple | 3 |
| | Banana | 5 |
| | Orange | 4 |






Using the Table

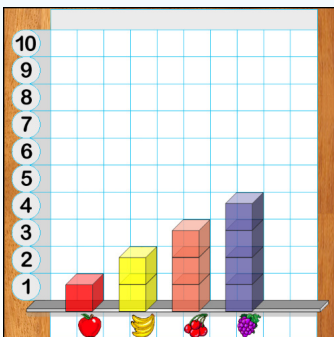
Tap the table icon to show the table associated with the current graph. In the Hands-On Math Graph Cubes app the table and graph are two-way interactive. Changes made to the graph are instantly reflected in the table and change made to the table are instantly reflected in the graph.

Labels in the table can be changed by dragging and dropping a sticker on any row. A number in the graph can be added or changed by dragging and dropping a number from the scale onto one of the rows of the graph.



5

|  | Apple | 3 |
|---|--------|---|
|  | Banana | 5 |
|  | Orange | 4 |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |



Instructional Goals

highest/lowest

range

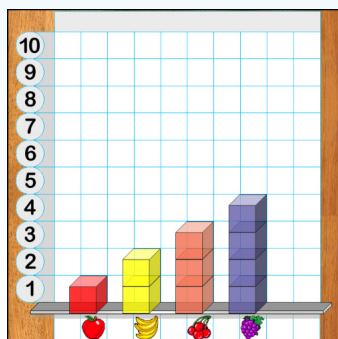
mean

difference

survey

greatest/least

average



In general the purpose of using Graph Cubes as a math manipulative is provide students with activities that involve collecting, describing, visualizing, and analyzing data based on real-life situations. We want to encourage students to think about data in mathematical terms. Key words are important for students to learn and Graph Cubes is a tool to help teachers illustrate words associated with data analysis..

Several of the activities involve collecting data in response to survey questions and using the answers to the survey questions to build graphs. Teachers will want to lead students in discussions that involve summarizing the information contained in their graphs. Students should be encouraged to explore the relationships revealed by a graph.

Discuss with students the implications of adding new data to a given chart or graph. Help students see that tables are a common way to organize a data set. Students will begin to realize that information organized in a table in many cases can be converted to a graph which is a pictorial representation that is helpful in providing insights into the data.

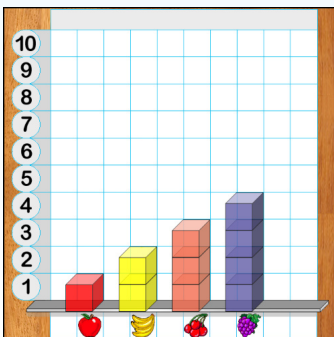
As students use this app they should begin to expand their mathematical vocabulary. Encourage students to give verbal descriptions of the graphs that they create while using the app. Some of the activities require the students to work in small groups and this is an opportunity to use mathematical language in sharing and refining ideas. In large group instructional situation with your iPad connected to a projection device teachers can demonstrate a variety of mathematical concepts related to data analysis using the app.

Teachers will want to guide the learning experience with questions that help students focus on data analysis skills. “Which pet was the most popular?” “Which color was chosen the least?” “How many more students chose football compared to baseball as their favorite sport?”

Hand-On Math Graph Cubes is designed to be used at a variety of grade levels. It is appropriate for individual, small group or classroom learning situations

Activities

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Building a Graph with Graph Cubes



Settings

Tap the Settings icon and change the options.



Sound Effects



Speech Enhancements

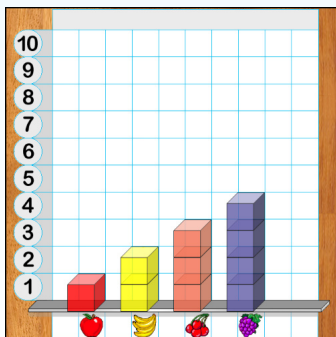
Tap the home icon and return to the top level. Tap the green arrow to begin. If necessary tap the eraser to erase the graph.



Home



Eraser

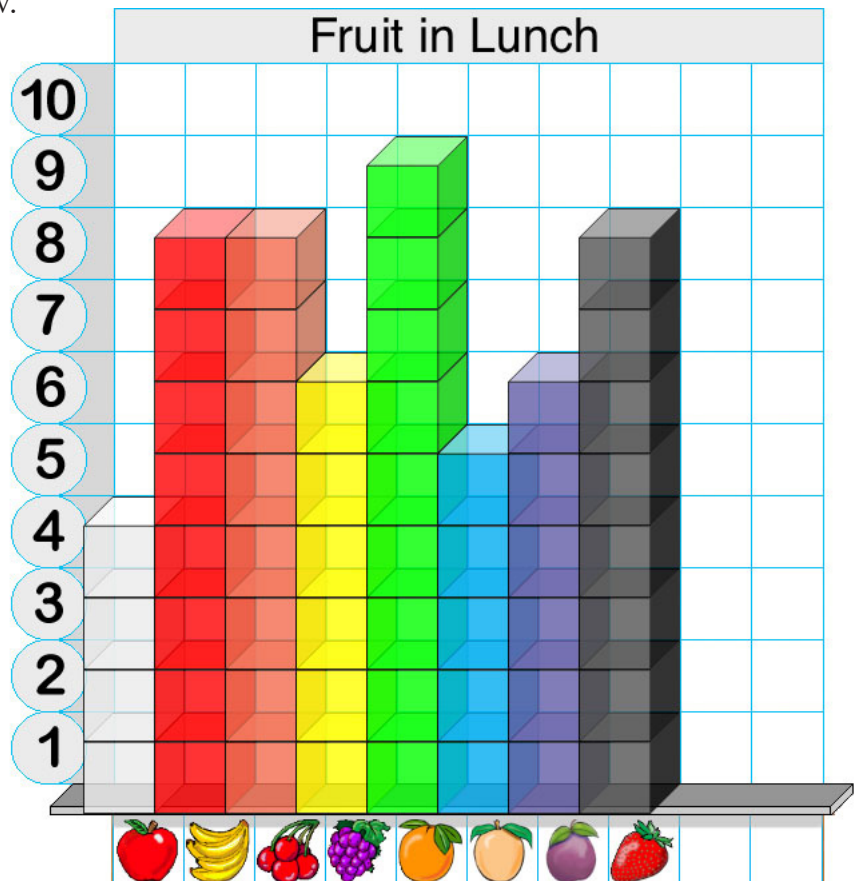


Let's begin exploring Graph Cubes by building a graph to show the results of a survey.

Alison asked 54 people at her school to answer the question, "Which type of fruit is in your lunch?" She used a chart to collect the answers.

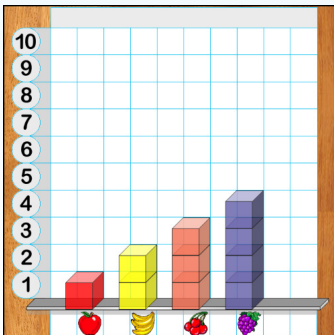
| | | |
|--|------------|---|
| | Apple | 4 |
| | Banana | 8 |
| | Cherry | 8 |
| | Grapes | 6 |
| | Orange | 9 |
| | Peach | 5 |
| | Plum | 6 |
| | Strawberry | 8 |

Use the Hands-On Math Graph Cubes app to build a graph to show the results of Alison's survey. Compare your graph to the graph shown below.



Learning about Making Graphs

Sun
Mon
Tue
Wed
Thu
Fri
Sat

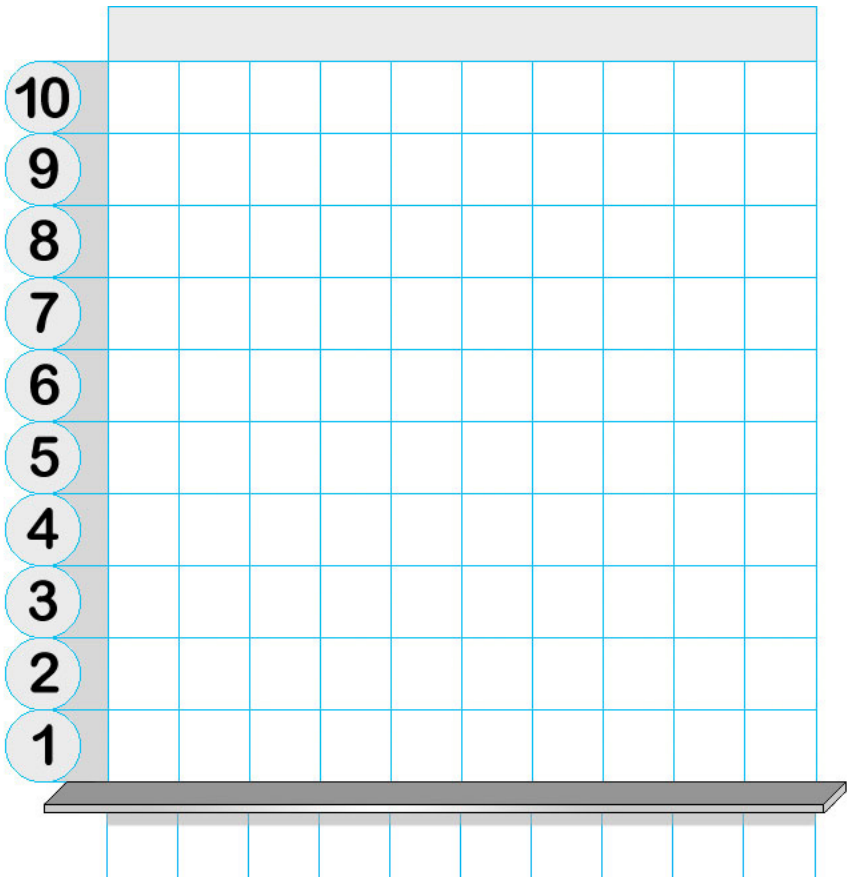


In this activity we will use Hands-On Math Graph Cubes to build a graph using the data in this chart.

Benjamin asked 25 of his classmates on what day of the week they were born. He made a chart to show the results of his survey.

| Day of Week | Count |
|-------------|-------|
| Sunday | 3 |
| Monday | 6 |
| Tuesday | 1 |
| Wednesday | 5 |
| Thursday | 5 |
| Friday | 4 |
| Saturday | 1 |

Use the data from Benjamin's chart to make a graph. Which day of the week has the greatest number? Which days of the week have the least number.



Favorite Day of the Week

Sun

Mon

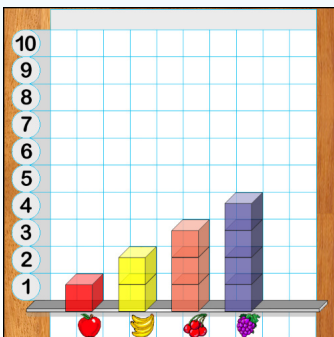
Tue

Wed

Thu

Fri

Sat



Tally marks are a useful way to count answers to survey questions. This table shows tally marks for the numbers from 1 to 10.

| | | | |
|---|------|----|----------|
| 1 | / | 6 | ### / |
| 2 | // | 7 | ### // |
| 3 | /// | 8 | ### /// |
| 4 | //// | 9 | ### //// |
| 5 | ### | 10 | ### ### |

Let's survey 20 of your classmates and use tally marks to collect the data. Ask, "Which day of the week is your favorite?" Some students might like Friday because it means the weekend is coming. Some might like Wednesday because that is piano lesson day.

| Day of the Week | Tally |
|-----------------|-------|
| Sunday | |
| Monday | |
| Tuesday | |
| Wednesday | |
| Thursday | |
| Friday | |
| Saturday | |

Use the Hands-On Math Graph Cubes app to make a graph to show the results of your survey.

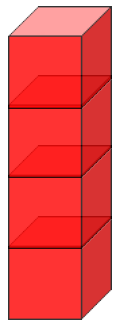
Begin by selecting the stickers option. Tap the arrow buttons to switch sticker sets. Find the days of the week stickers.



Drag the days of the week to label the columns of the graph.

| Day | Mon | Tue | Wed | Thu | Fri | Sat | Sun | | |
|-----|-----|-----|-----|-----|-----|-----|-----|--|--|
| | | | | | | | | | |

Switch back to cubes and stack cubes in the columns of your graph to show the results of your survey.

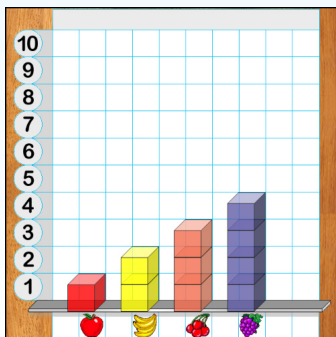


1. Which day of the week was the favorite?

2. Which day of the week was the least favorite?

3. Did any of the days of the week get the same number of votes?

Favorite Holidays



Let's find out which holiday is the favorite. Ask 10 people in your class to answer the question, "Which of these holidays do you like the best?" Make a chart to show the results.

| Holiday | Count |
|------------------|-------|
| New Years Day | |
| Groundhog Day | |
| Valentine's Day | |
| Halloween | |
| Christmas | |
| Hanukkah | |
| Thanksgiving | |
| Independence Day | |

Use Graph Cubes to make a graph. Use the results of your survey to do these arithmetic problems.

Holiday Math Challenge

$$\text{Jack-o'-lantern} + \text{Menorah} = \square$$

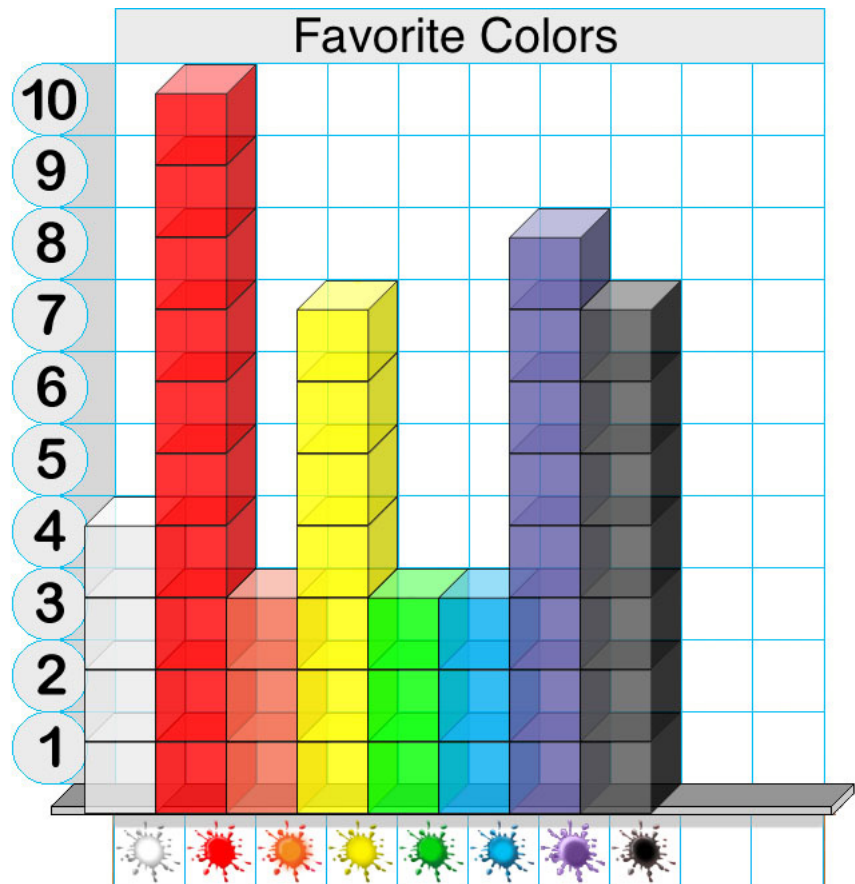
$$\text{Heart} + \text{Firecracker} = \square$$

$$\text{Cupid} + \text{Menorah} = \square$$

$$\text{Wreath} + \text{Groundhog} = \square$$

Favorite Colors

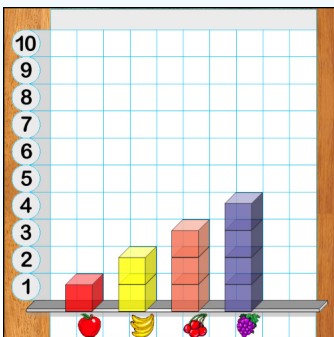
Which color do you like the best? Jonathan took a survey of 45 students to find out which colors are the most popular. He made this graph to show the results of his survey.



1. Which color was the favorite?

2. How many more students chose red rather than green?

3. How many more votes are needed for orange in order to tie with red?



Eye Color

Look into the eyes of some of the students in your class. Why do some people have green eyes while others have brown eyes? It's all about genes! Every cell in the human body contains about 25,000 to 35,000 genes. Genes carry information that determines personal traits. Traits are characteristics that are inherit from your parents. Parents pass some of their characteristics on to their children through genes. For example, if both of your parents have blue eyes, you might inherit the trait for blue eyes. If your mother has freckles, you might inherit that trait and wind up with freckles on your face. All living things have genes not just humans. Animals and plants have genes, too.

Let's be research scientists and find out more about the eye color of the students in your class. Make a chart with tally marks to show the eye color of 10 people in your classroom.

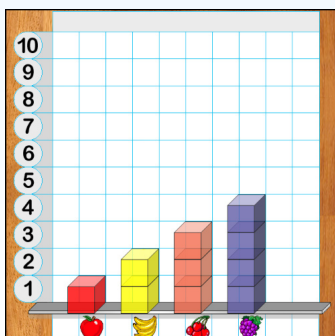
| | |
|---|--------------|
|  | Blue |
|  | Green |
|  | Hazel |
|  | Brown |

Use Graph Cubes to make a graph to show the results of your research project. Answer these questions.

1. Which eye color was the most common?

2. Which eye color is the least common?

3. If you studied 100 people, how many do you think would have brown eyes?



Hair Color

DNA is short for deoxyribonucleic (say: dee-ox-see-ri-bo-nyoo-clay-ik) acid.

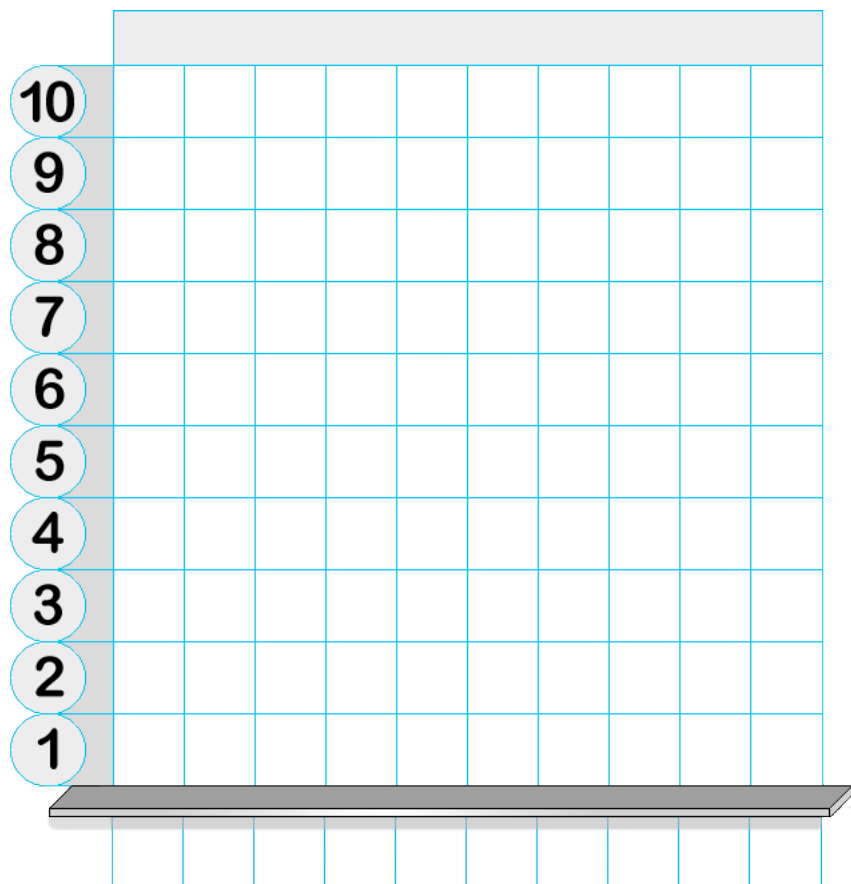
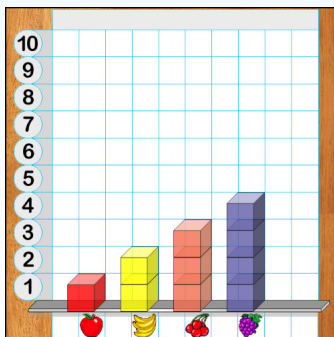
Like eye color, hair color is also determined by genes. Genes make up chromosomes. Chromosomes come in pairs. There are usually hundreds and sometimes even thousands of genes in one chromosome. Chromosomes and genes make up DNA.

Chromosomes are very small units that are found inside cells. Every living thing is made up of these very small units. Cells are so tiny that you can only see them through the lens of a strong microscope. The human body is made up of trillions of cells. Usually a cell has only one nucleus. The nucleus tells the parts of a cell what to do. Chromosomes and genes in the nucleus of cells determine hair color.

Look around your classroom. Make a table to show how many students have red, brown, blonde or black hair.

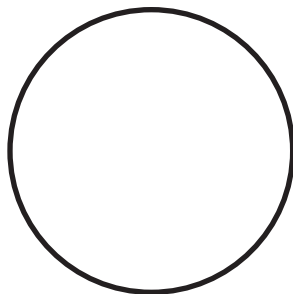
| Hair Color | Count |
|------------|-------|
| Blonde | |
| Red | |
| Brown | |
| Black | |

Use Graph Cubes to make a graph to show the results.

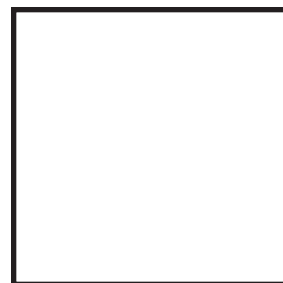


Random Shapes

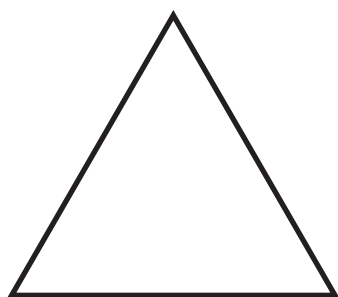
Use card stock to cut out five of each of these shapes.



circle



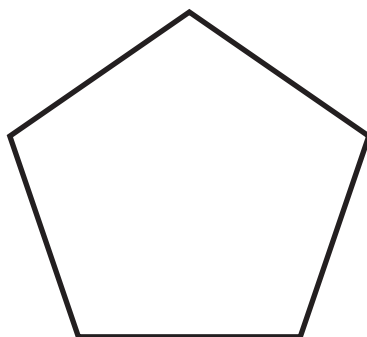
square



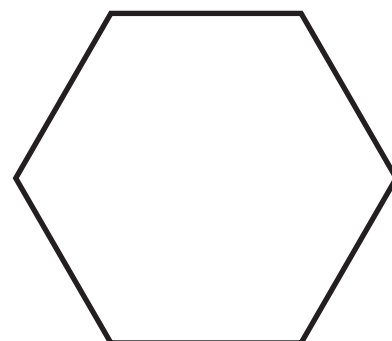
triangle



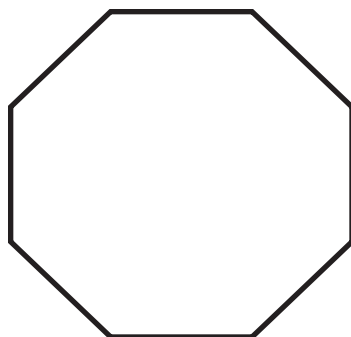
rectangle



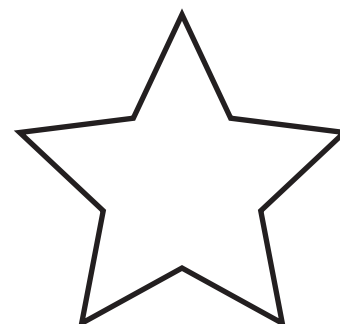
pentagon



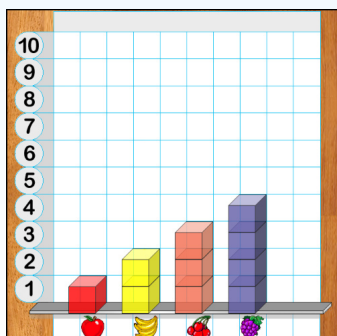
hexagon



octagon



star

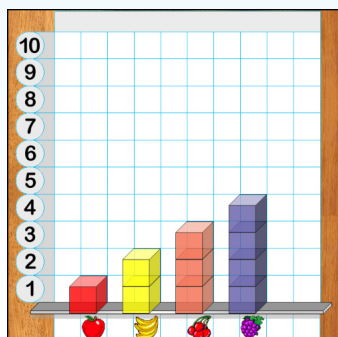
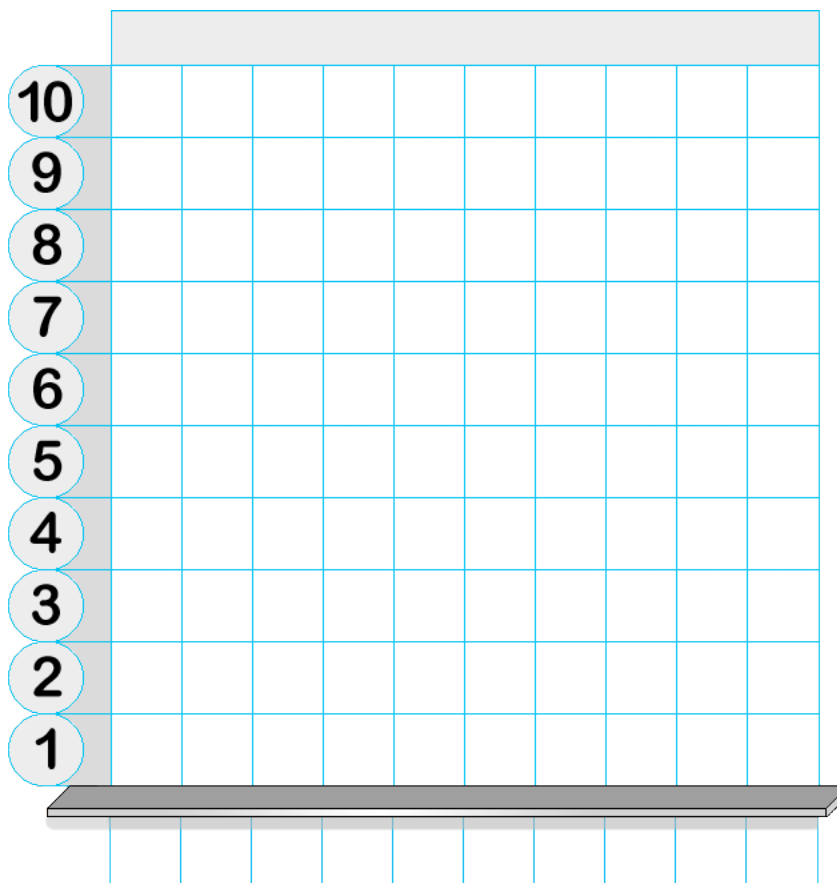


Random Shapes

Put five of each shape into a box. Without peeking reach in to the box and remove 20 shapes, one at a time. As you remove shapes record which type of shape you picked. Make a table to record the shapes that you drew.

| Shape | Count |
|-----------|-------|
| Circle | |
| Square | |
| Triangle | |
| Rectangle | |
| Pentagon | |
| Hexagon | |
| Octagon | |
| Star | |

Use Graph Cubes to make a graph to show the results of your experiment.



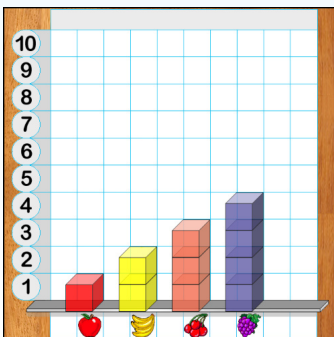
List the shapes drawn from the box in order from least to greatest.

Feelings

“How’s it going today?” That’s a question you often hear people ask each other. People want to know how others are feeling. Sometimes you feel happy or sad, surprised or puzzled. Maybe you were up past your bed-time doing homework and you feel tired. Maybe you have a test coming up and you are worried.

In this project we will use Graph Cubes to make a graph that tells how your classmates are feeling.




Remember: If you are ever very upset about something you can always talk to your parents, teacher or counselor.

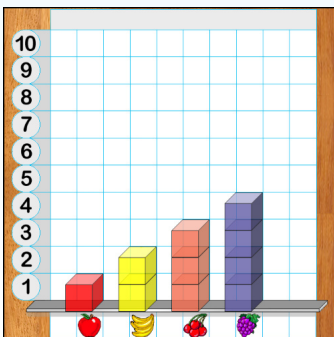


| Symbol | Feeling | Count |
|---|-----------|-------|
|  | Happy | |
|  | Angry | |
|  | Puzzled | |
|  | Sad | |
|  | Surprised | |
|  | Tired | |
|  | Silly | |
|  | Worried | |

Classmates and Pets

Probably many of the students in your class have a pet. Let's find out what kinds of pets your classmates have and use Graph Cubes to show what we find out.

| Symbol | Pet | Count |
|---|--------|-------|
|  | Cat | |
|  | Dog | |
|  | Fish | |
|  | Frog | |
|  | Mouse | |
|  | Rabbit | |
|  | Snake | |
|  | Turtle | |



Hands-On Math Graph Cubes

Ventura Educational Systems

