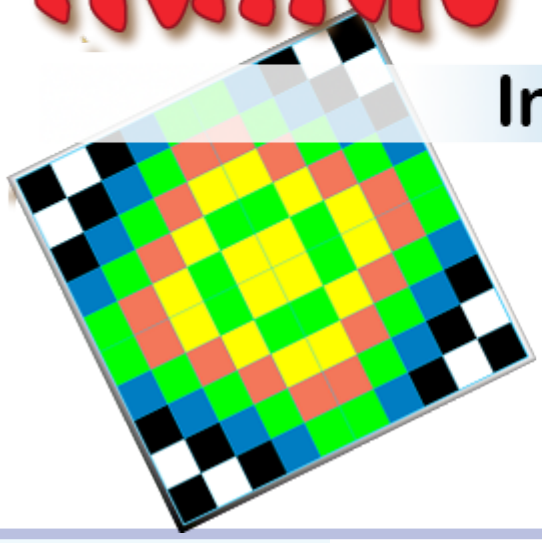
Ventura®
Educational Systems

Tools for Active Teaching and Active Learning

Hands-On Math

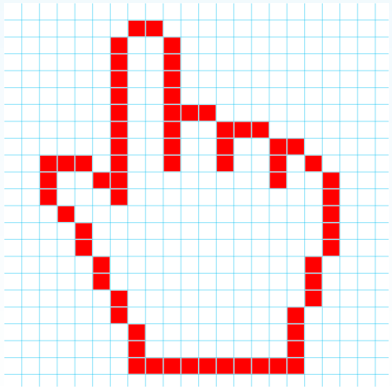
Interactive Color Tiles



Explore and Discover:

- Number Theory & Concepts
- Basic Operations
- Patterns & Symmetry

Instructor's Guide



Ventura Educational Systems

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Credits

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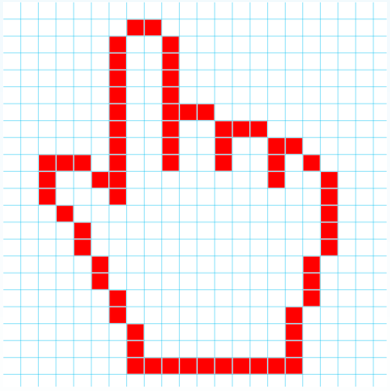

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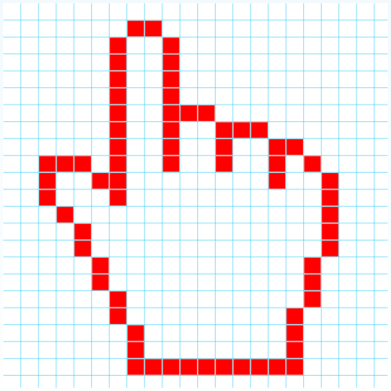


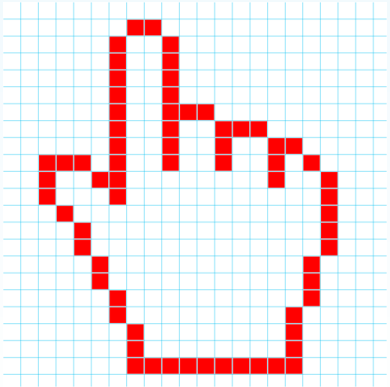
Overview

The use of a Color Tiles is one of the best ways to give students an insight into a variety of important mathematical topics. Because children naturally like to build and create, engaging them at an early age in constructive mathematical discovery and exploration, helps them view mathematics as an exciting subject. Mathematics is a universal language, so much so, that when when the Voyager spacecraft was sent on a journey that would take it beyond our solar system, the language of mathematics was used to carry a message of greeting from the humans on earth to any intelligent civilization out there amongst the stars.

Children can begin their personal exploration of mathematics by using the Hands-On Math Interactive Color Tiles Playground to define sets of numbers and discover their properties and relationships. Children will begin to identify important mathematical concepts as they interact with tools provided in this software application. Pattern recognition is one of the first concepts presented to young children. It is an important component of the continuum of skills and concepts that permeate the K-12 math curriculum. Research has shown that children learn best through active involvement in the learning process. Hands-On Math: Interactive Color Tiles is designed to be a tool that teachers can use for active teaching and active learning. Math manipulative devices offer a rich source of teaching strategies for problem solving and can be very helpful in developing an intuitive understanding of mathematical concepts. In the Hands-On Math series we suggests ways in which concrete learning experiences can be extended to a representational level while remaining manipulative and interactive.

Can learning math be a creative process or is it all about drill and practice?

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 the simulated manipulative device. The second section of the manual is a set of curriculum-based activities that are designed to help the teacher use the Hands-On Math app in the classroom. These activities have been developed for elementary and middle school age students and are arranged by order of grade level where the concepts are typically introduced. 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, patterns and sequences, basic computation, geometry, graphing and symmetry. Each activity is meant to be a beginning. Teachers will want to encourage the children to explore extensions of each activity. Orally discussing each activity will help to foster higher level thinking.



Hands-On Math: Interactive Color Tiles 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.

Introduction to Hands-On Math: Interactive Color Tiles

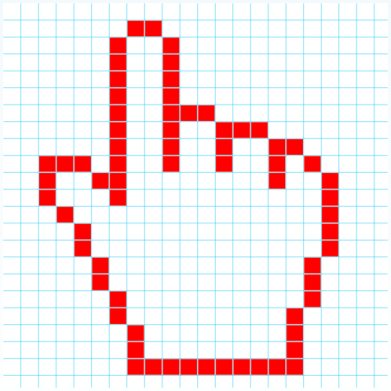
Jean Piaget developed his theories of education decades before the advent of computers being used in classrooms, so it is difficult to know what his thoughts might be regarding how these marvelous tools should be used, but we can assume that based on the importance he gave to interaction as a part of the learning process, he would probably want computers to also be used as tools for interactive learning. Through research we know that approaches to teaching 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 accomodate new discoveries which expand our understanding of the learning process and new technologies which expand our delivery systems.

According to modern learning theory which relies greatly on Piaget's seminal work, 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.

Piaget's theory of cognitive development can be used as a tool in the early childhood classroom. According to Piaget, children developed best in a classroom with interaction.

For learning mathematics an active teaching and active learning environment is a very desirable. 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 skills and 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. Piaget has contributed a great deal to support this theory, and to foster the development of educational strategies which are consistent with the theory. The Hands-On Math Series is unique because it combines an interactive learning environment that can be easily manipulated by children with intelligent feedback from the computer. Hands-On Math Color Tiles can be thought of as artificially intelligent math manipulatives that provide a virtual learning environment that is powerful and unique - perfect for creative teaching approaches.



Using an iPad in a Manipulative Approach to Math

Hands-On Math: Interactive Color Tiles combines and extends the use of concrete materials for teaching mathematics to the touch-based interactive enviroment 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 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 transition to a representational stage and serves as a foundation for the development of abstract mathematical thinking skills.

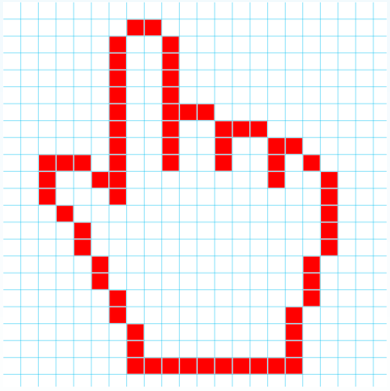
Once mathematical concepts have been internalized by the child in a concrete way, the stage is set for a deeper understanding of the more formal, abstract axioms of higher mathematics.

Hands-On Math: Interactive Color Tiles simulates the use of 1 inch square color tiles on a grid. Traditionally students would use a set of wooden or plastic tiles to create patterns and sequences, to represent sets for basic computation, and to discover and explore other concepts related to geometry and statistics. Physical manipulative devices are available commercially. The app simulates these instructional approaches by creating an open-ended area called the Color Tiles Playground. On the Color Tiles Playground students manipulate virtual color tiles in much the same way that physical color tiles would be used to discover, investigate, test, validate, explore and internalize fundamental math concepts.

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

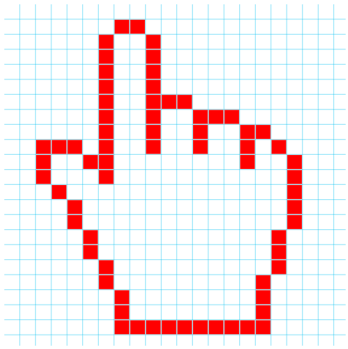
Using the Color Tiles Playground students can investigate and experiment with a variety of mathematical ideas. The author and designer coined the term, "artificially intelligent math manipulative" to describe how using the Hands-On Math Color Tiles differs from concrete manipulative devices traditionally used in classrooms. The use of the Hands-On Math Interactive Color Tiles provides intelligent feedback as the student manipulates the device.

The Hands-On Math Color Tiles Playground is an excellent tool for open-ended discovery, but can also be 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 device direct students into more structured investigations. Students will make discoveries and when they do teachers should encourage them to share their discoveries with others in their group.

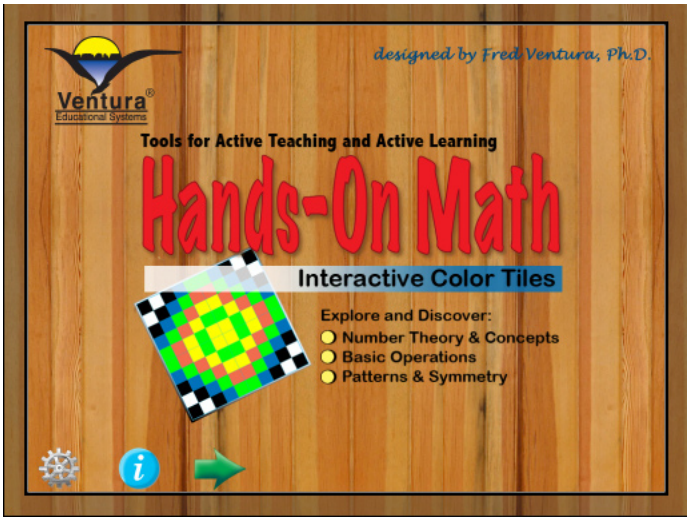


Getting Started

Hands-On Math: Interactive Color Tiles encourages exploration. 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: Interactive Color Tiles icon to launch the app.

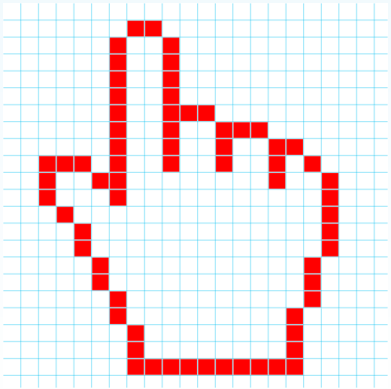


The opening view presents the title page with three options:

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

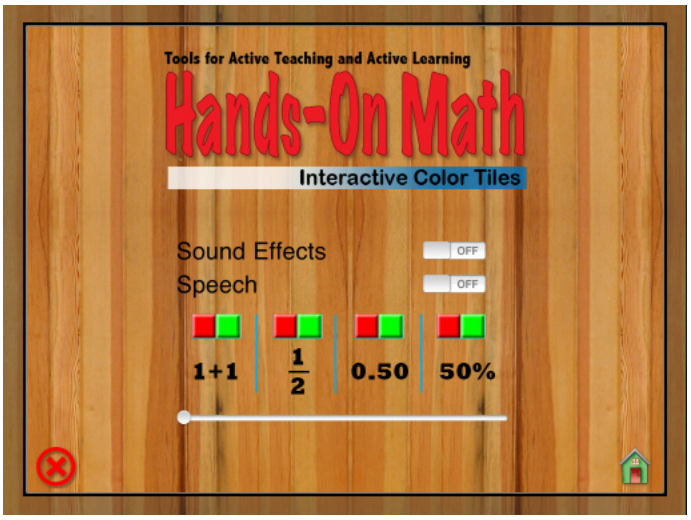
Info - Tap this icon to access the User's Guide where an overview of the app is presented.

Begin - Tap the green arrow to start using the Hands-On Math: Interactive Color Tiles Playground.



Settings

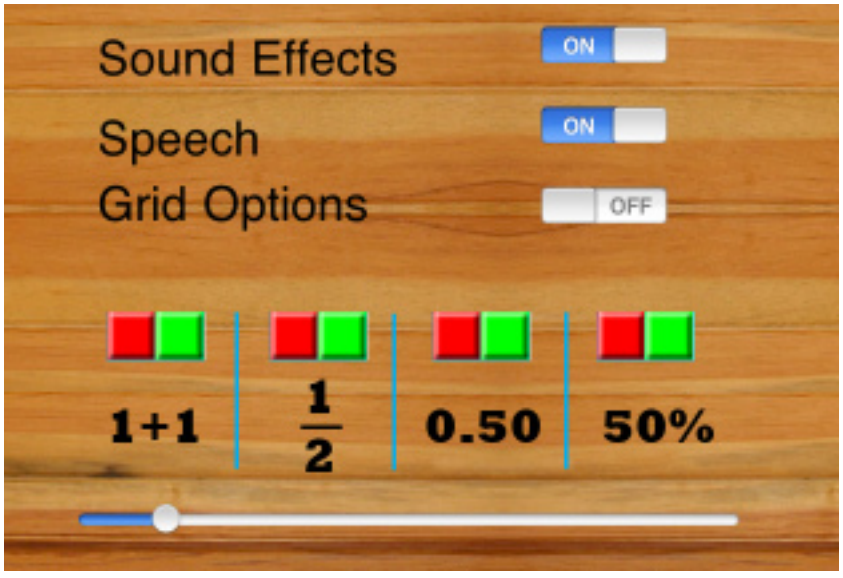
The Settings option provides control of some of the basic features of the app. Options include control for sound effects and speech.

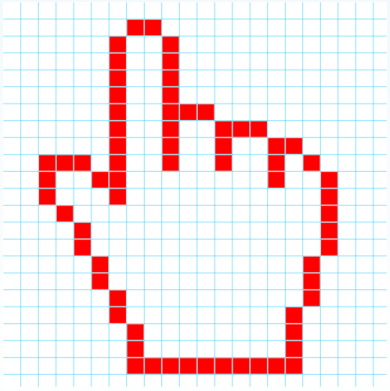


Mild sound effects are used through out the app and add a level of interest for students. When using the app with very young students teachers may wish to have the Speech option on. When Speech is on the name of each color is pronounced when a Color Tile is tapped.

Use the on/off switch to activate or deactivate Sound Effects and Speech. Enable or disable Grid Options with the Grid Options switch.

Use Speech effects with very young children to help them learn the names of the colors.

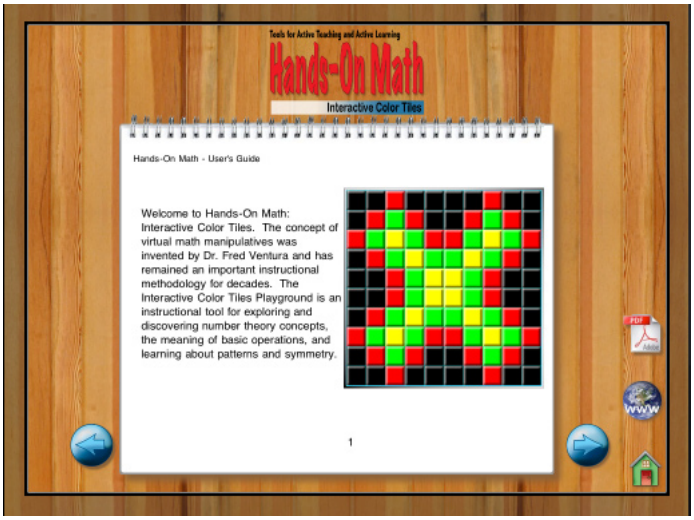




Use the slider to set the display mode for the Chart. The report that appears on the can show whole numbers, fractions, decimals or percents.

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.

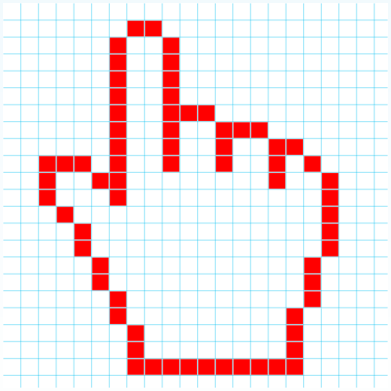
Exit the user's guide by tapping the home icon.

Swipe right or left to change pages.

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

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

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



Color Tiles Playground

The Interactive Color Tiles Playground is where the fun begins. Tap the green arrow to get started. Holding your iPad in the portrait orientation you will notice eight Color Tiles at the top of the screen. In landscape orientation the Color Tiles appear on left side of the screen.

Eight Colors Tiles

Red

Blue

Orange

Purple

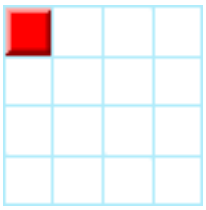
Yellow

Black

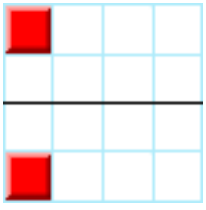
Green

White

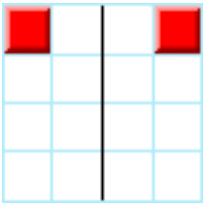
Four Mirror Options



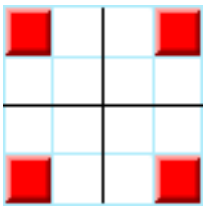
No Reflection



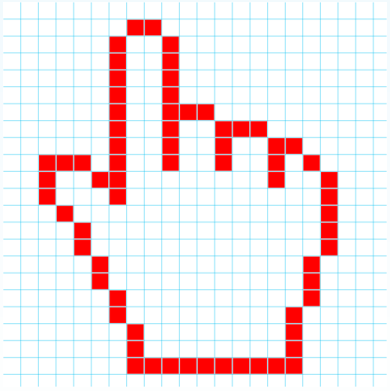
Vertical Reflection



Horizontal Reflection



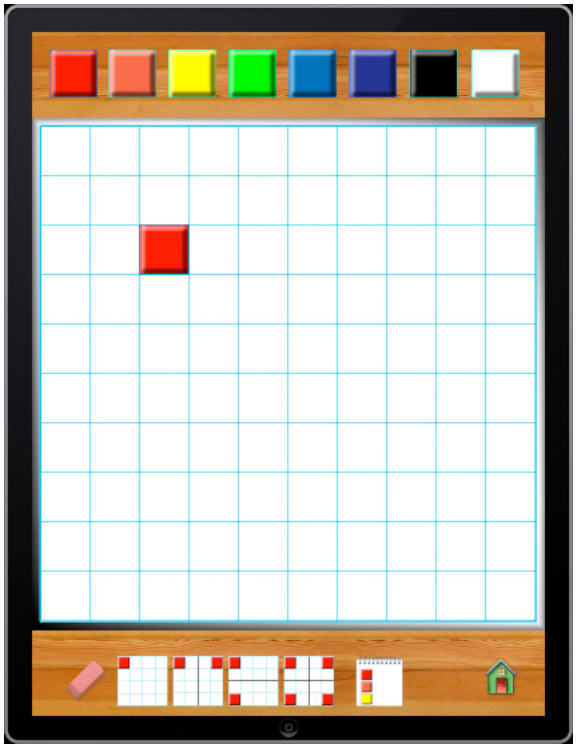
Horizontal and Vertical Reflection



Placing Color Tiles on the Hands-On Math Interactive Playground

The Color Tiles vary in color and can be placed anywhere on the grid. The tiles are available in eight different colors: red, orange, yellow, green, blue, purple, black and white. Tap one of the eight color tiles to designate the color of any new tiles placed on the grid. Tap the grid to place a Color Tile. Here for example a red Color Tile was placed in column 3 and at row 3.

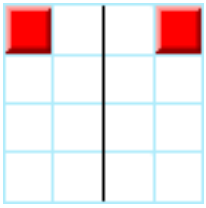
Color Tiles are very useful math manipulatives and can be used to develop many skills, including: counting, addition, subtraction, place value, multiplication, division, fractions, patterns, area, probability and graphing.



Once a Color Tile has been placed on the screen, it can be picked up and moved to a new position by dragging it to the new location.

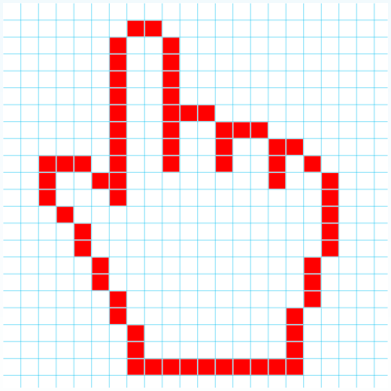
Individual Color Tiles can be removed from the screen by selecting a tile and dragging it off the grid.

Tap the eraser icon to remove all the Color Tiles from the Playground.



Horizontal Reflection

Tap the Horizontal Reflection icon to put the Playground in horizontal reflection mode. When this setting is used Color Tiles are automatically reflected across an imaginary line drawn vertically at the center of the grid. Likewise Vertical Reflection or both Horizontal and Vertical Reflection modes can be selected.



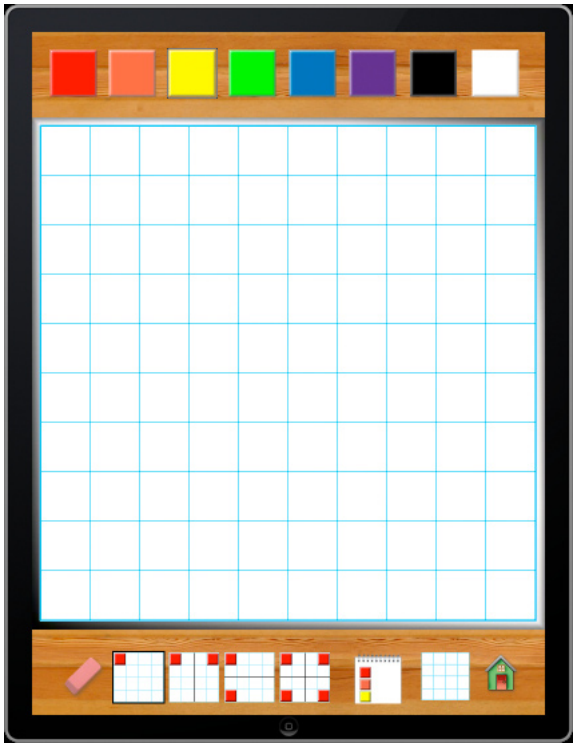
Advanced Options

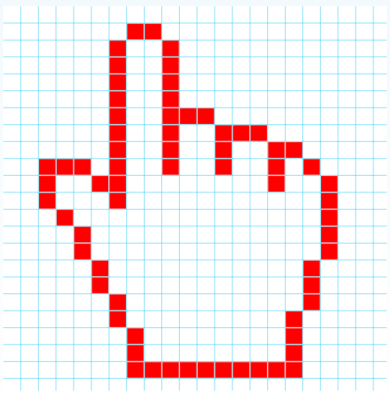
Chart Icon

Tap the Chart icon to put the Playground in Smart Mode. When this icon is selected at notebook appears over the grid reporting the number of each color of tile used on the grid and also the total number of tiles. Display setting control whether whole number, fractions, decimals or percents are displayed.

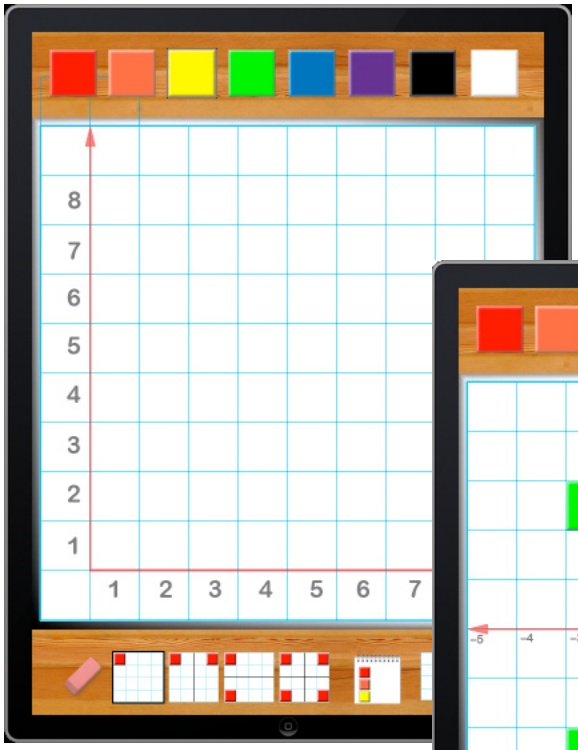
Grid Options Icon

The default mode of option is for the Playground to be displayed as a 10 × 10 grid. However for some lessons teachers may want to use the various grid options available in the app. Tap the icon to change the grid.

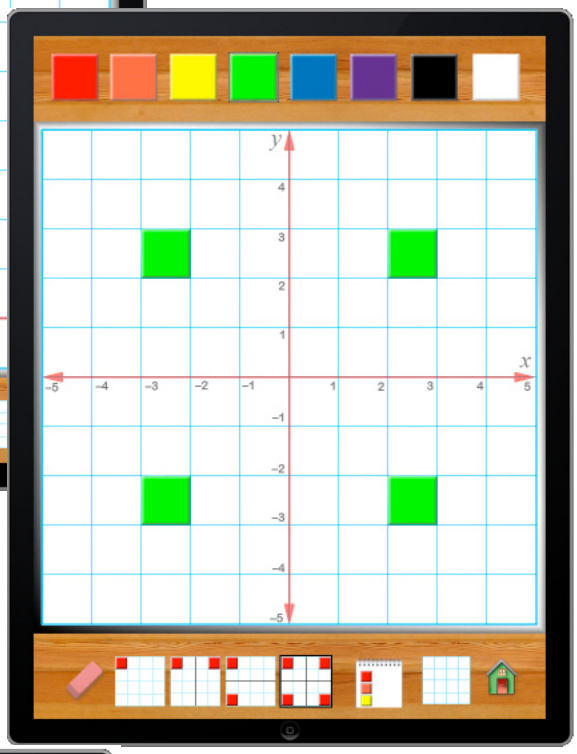




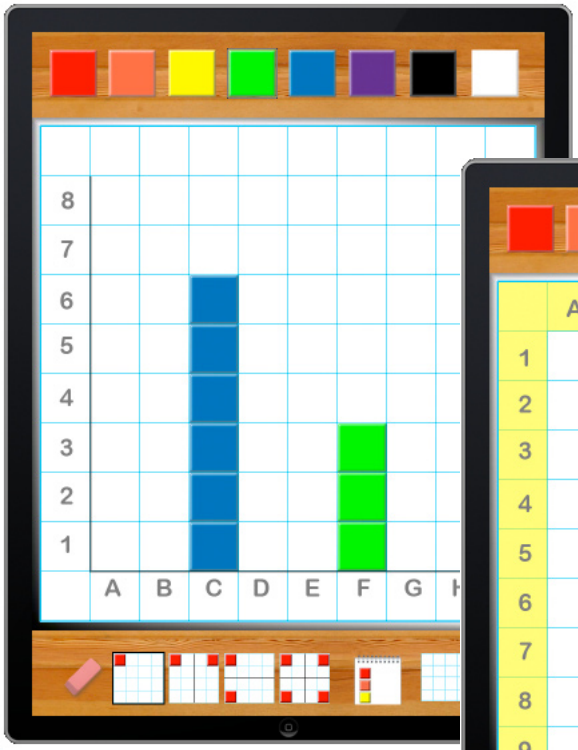
Cartesian Plane



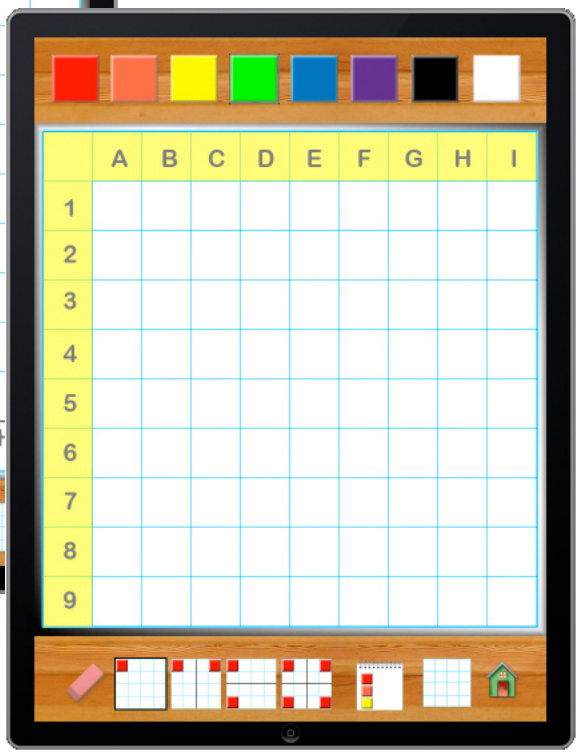
Tap the Grid Options icon to display Quadrant I of the Cartesian Plane over the Playground. Use this grid for introductory activities involving coordinate pairs.



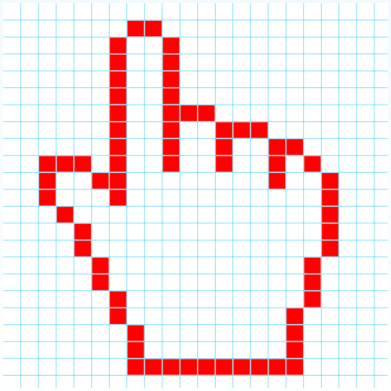
Tap the Grid Options icon a second time to display a four quadrant Cartesian Plane over the Playground. This option is useful in lessons involving reflection and symmetry.



A third tap results in a grid suitable for making bar graphs.



And a fourth tap results in a grid that is layed out similar to a spreadsheet.



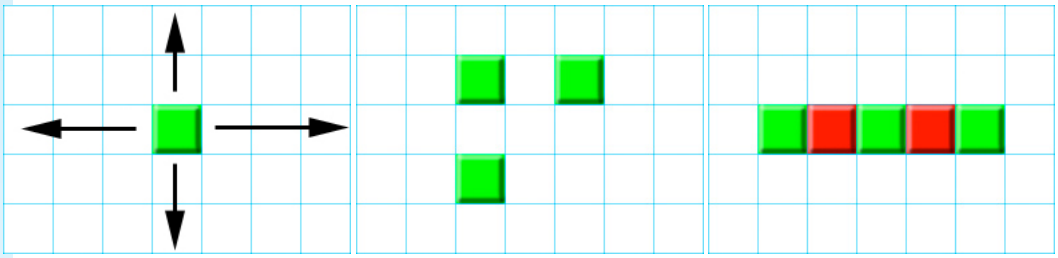
Instructional Applications

Math as Communication objectives can be addressed using Color Tiles. Help students acquire vocabulary related to position by stressing these terms: left, right, over, under, above, below, between, first second, third, beginning or last. Other terms include: equivalence, greater than, less than, symmetrical or asymmetrical.

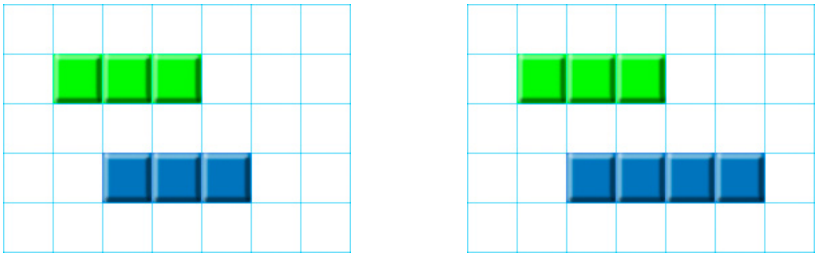
Effective mathematics education begins with active involvement with concrete objects. Through the use of manipulative materials children develop an intuitive understanding of mathematical concepts. Color Tiles are an interesting tool for exploring a variety of concepts. Teaching strategies that include the of Color Tiles will prove to be rewarding for teachers and students. Children will benefit from extended free play.

If teachers observer students whle they are engaged in free play with Color Tiles they will notice that children spontaneously discover important mathematical ideas. Here are a few possibilities.

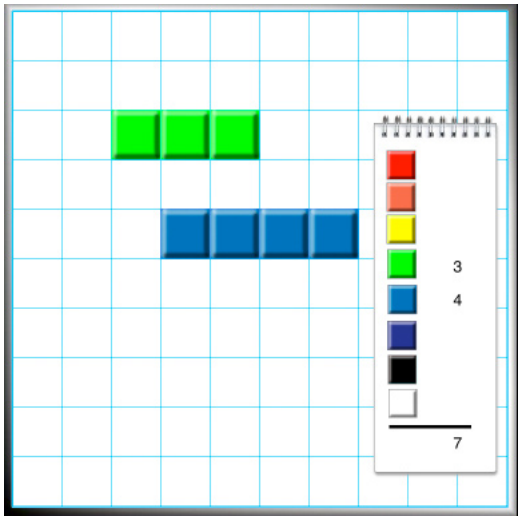
1. A tile can be placed to the left of other tiles or to the right of other tiles. Tiles can be placed over or under other tiles. Tiles can be above or below other tiles. Tiles can be between other tiles. Students can learn the meaning of first, second, and third as well as beginning or last.



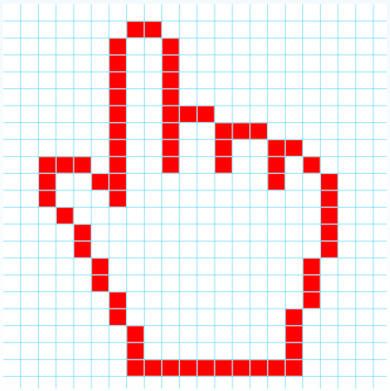
2. Two groups ca have the same number of objects (equivalence). Some sets have more objects than other sets (greater than), and some sets have fewer objects than other sets (less than).



3. Number symbols can be used to tell how many ojects are in a set.

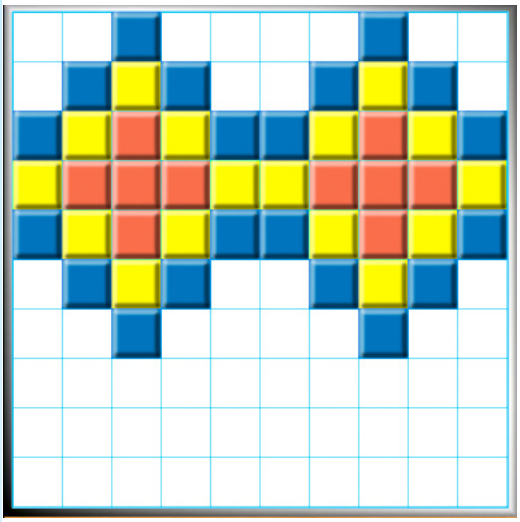


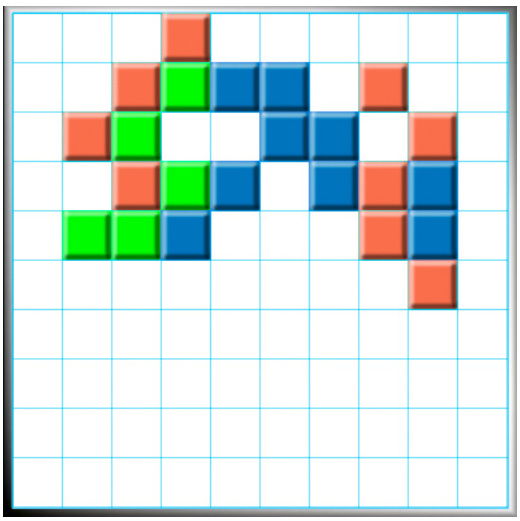
4. Addition is the process of finding the total number of objects in two or more groups.



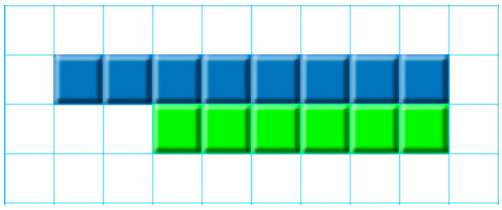
Instructional Applications

5. Some designs are symmetrical. Some designs are asymmetrical.





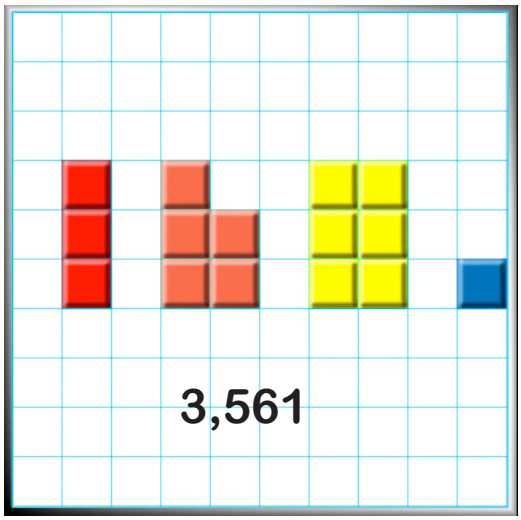
6. Addition facts can be shown with Color Tiles.



□ + 6 = 8

2 + 6 = 8

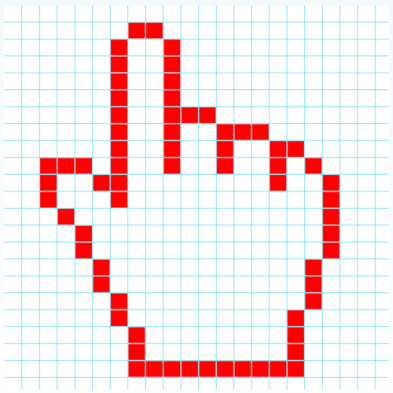
7. Color Tiles can be used to represent place value.



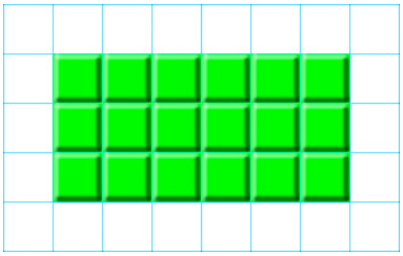
1 = 10

1 = 10

1 = 10



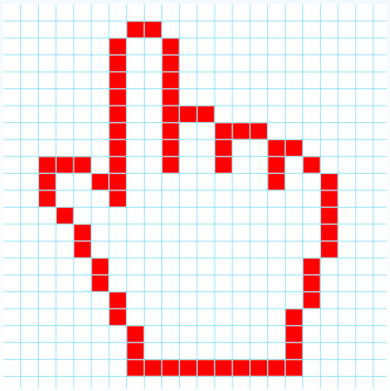
8. Rectangular arrangements of Color Tiles can be used to show multiplication.



3 × 6 = 18

Activities

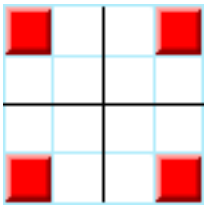
Several of the activities ask the students to record answers in their notebook. Teachers may want to use iPad's Notes app for this purpose.



Let's Make a Design

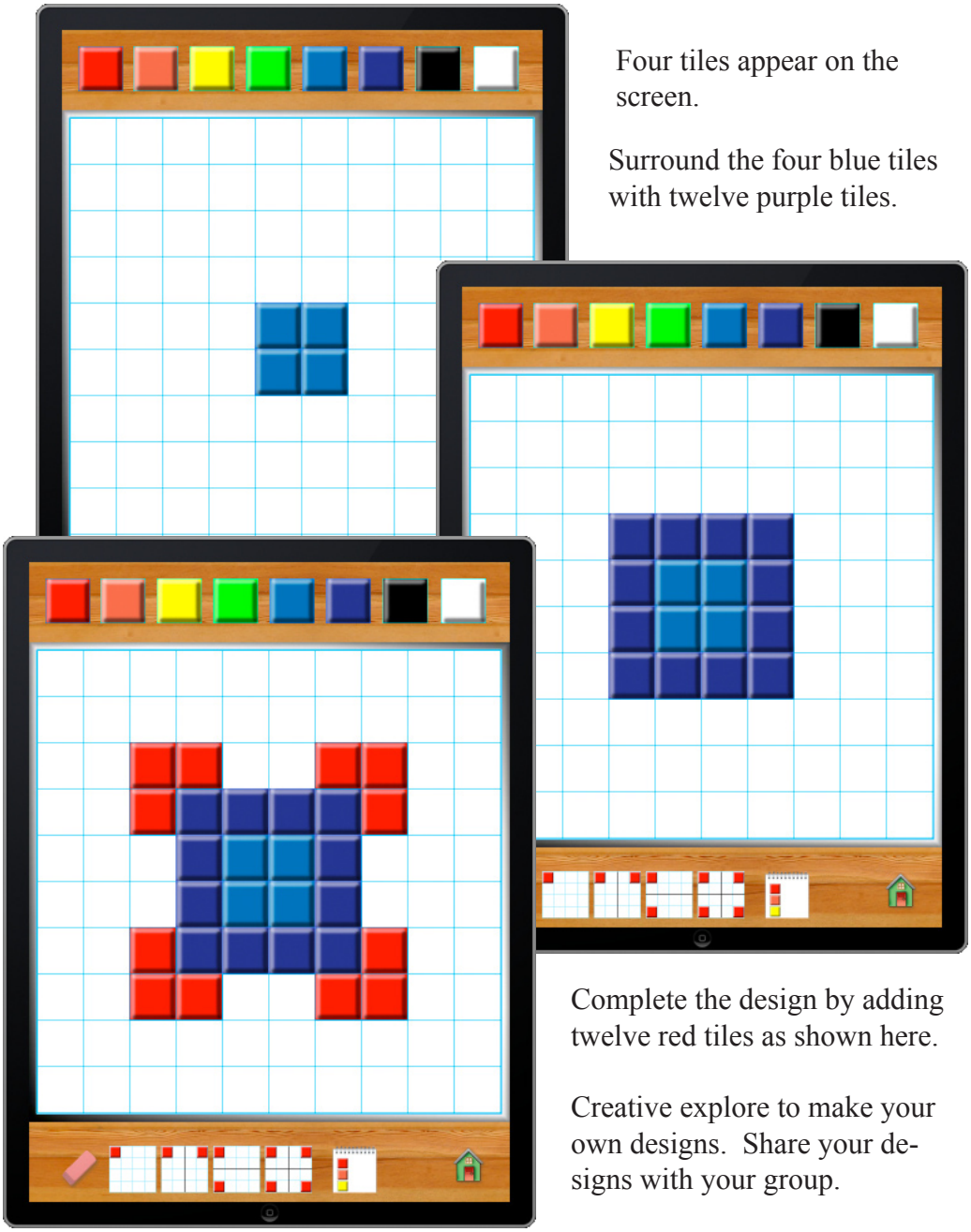
Early Learning Experience

Use the Color Tiles Playground to complete this activity. Verbally read each instruction to the students. Monitor and observe student activity.



Horizontal and Vertical Reflection

Tap the Horizontal and Vertical Reflection icon to set the mode for this activity. Tap the blue color tile and place it at the center of the grid.

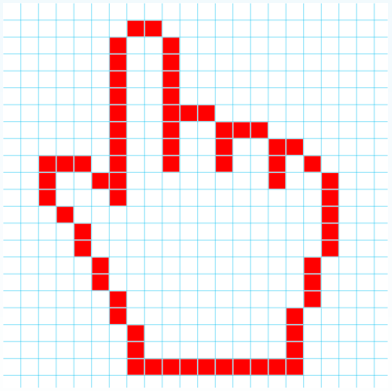


Four tiles appear on the screen.

Surround the four blue tiles with twelve purple tiles.

Complete the design by adding twelve red tiles as shown here.

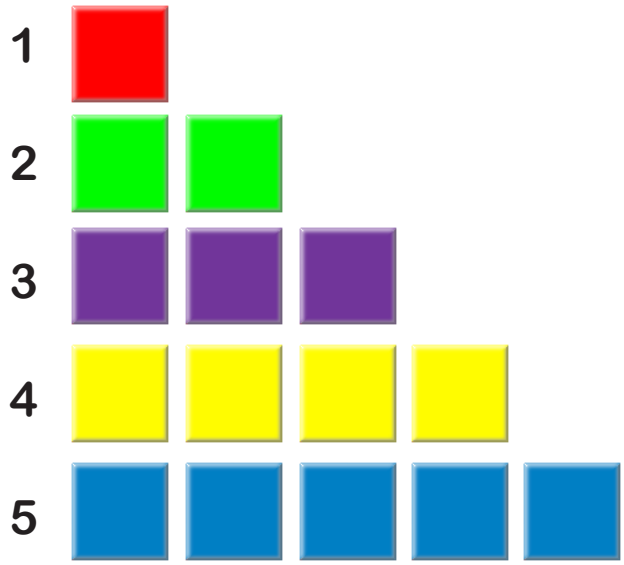
Creative explore to make your own designs. Share your designs with your group.



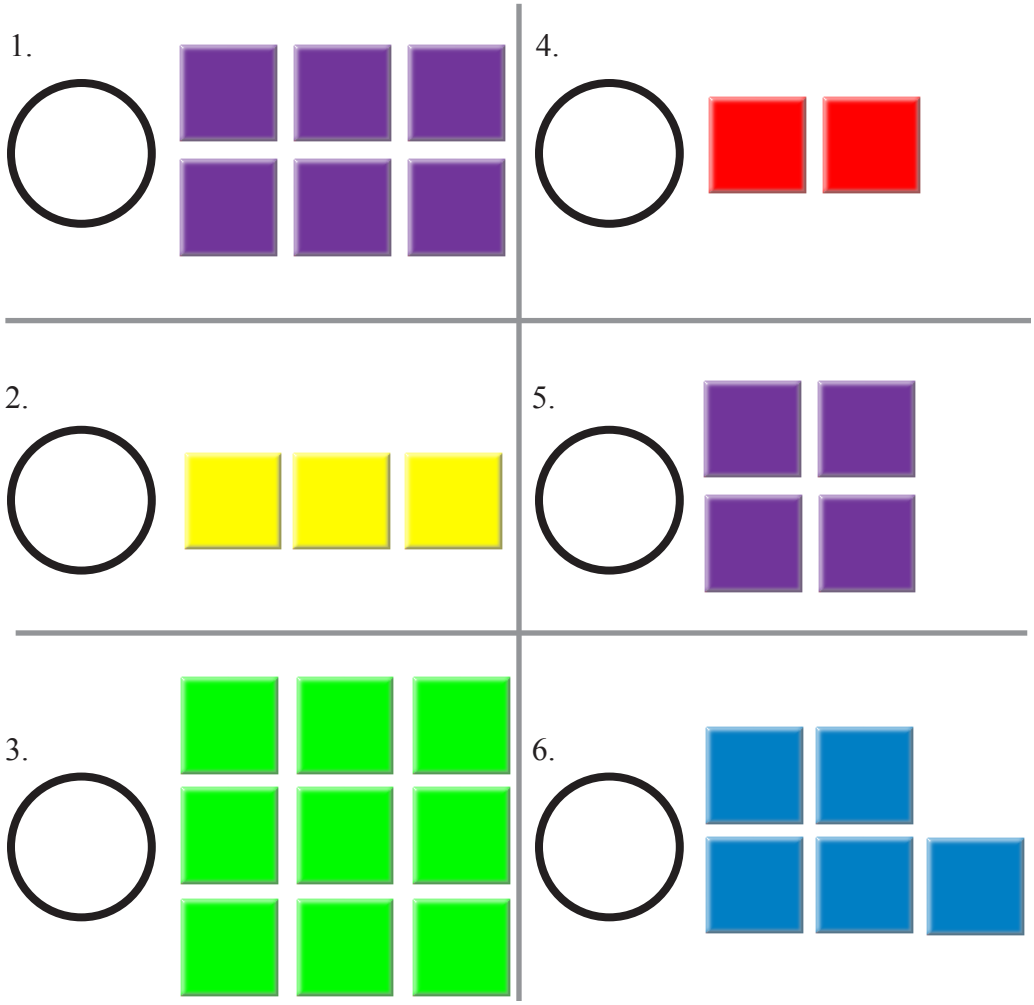
Explore Counting on the Color Tiles Playground

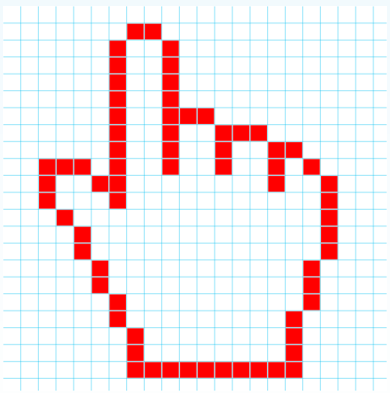
Early Learning Experience

Use the Color Tiles Playground to to show these numbers. Use a different color for each number.



Write a number in your notebook to show how many are in each set.

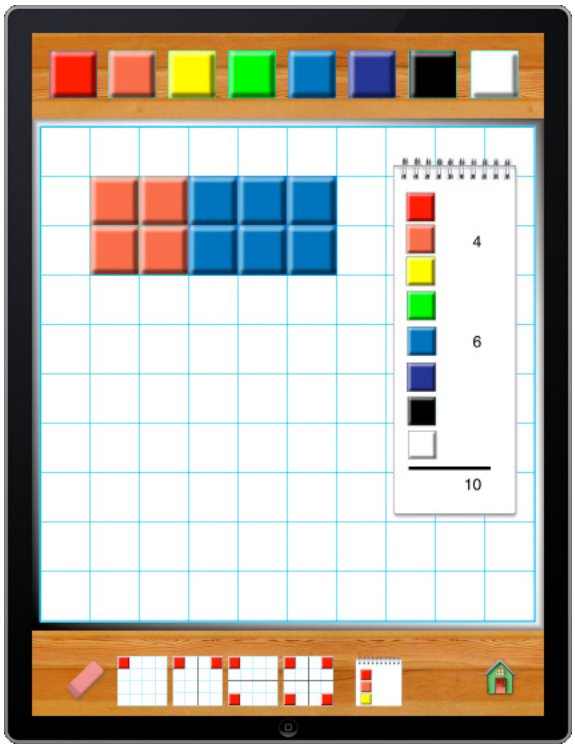




How Many Ways Can You Make a 10?

Early Learning Experience

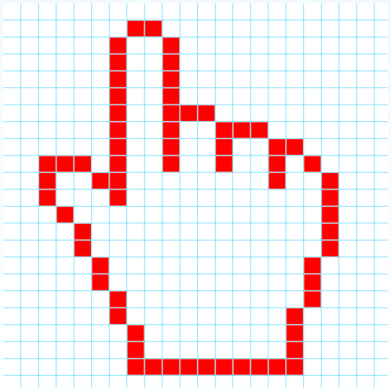
How many different ways can you make a group of ten color tiles. Use only orange and blue color tiles. Here's an example of one way to make a 10 using two different colors.



4 + 6 = 10

Make a chart in your notebook and record how many of each tile was used to make a 10.

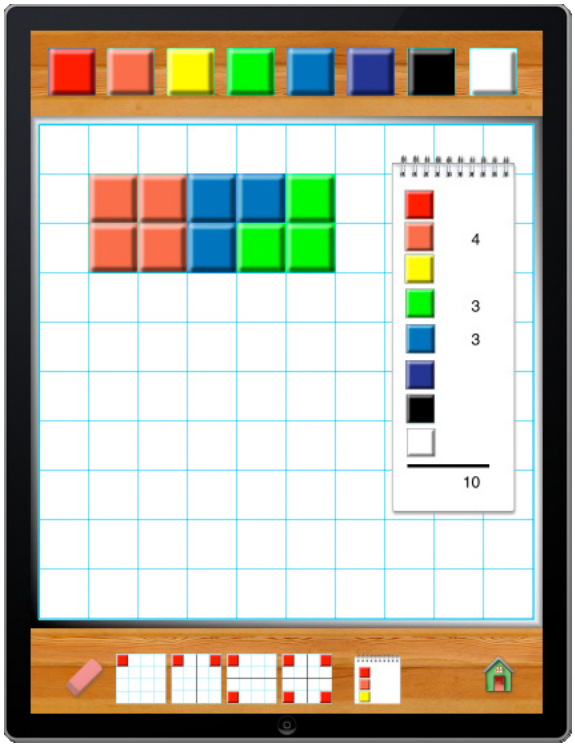
		Number Sentence
4	6	4 + 6 = 10



How Many Ways Can You Make a 10?

Early Learning Experience

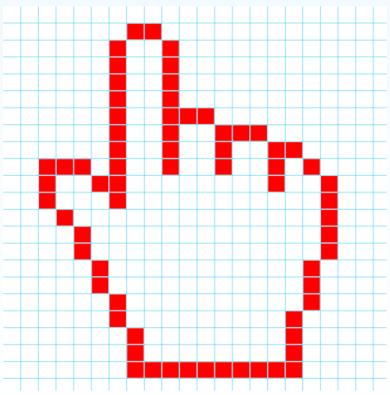
How many different ways can you make a group of ten color tiles. Use only orange, blue and green color tiles. Here's an example of one way to make a 10 using three different colors.



4 + 3 + 3 = 10

Make a chart in your notebook and record how many of each tile was used to make a 10.

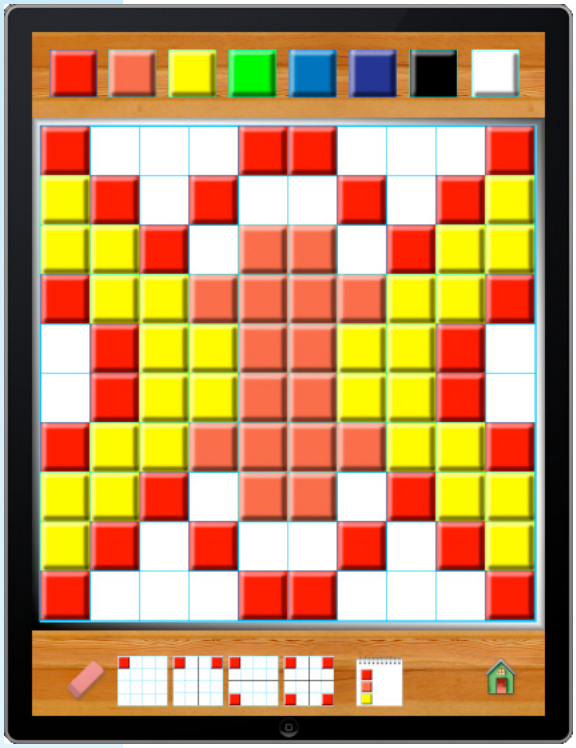
			Number Sentence
4	3	3	4 + 3 + 3 = 10

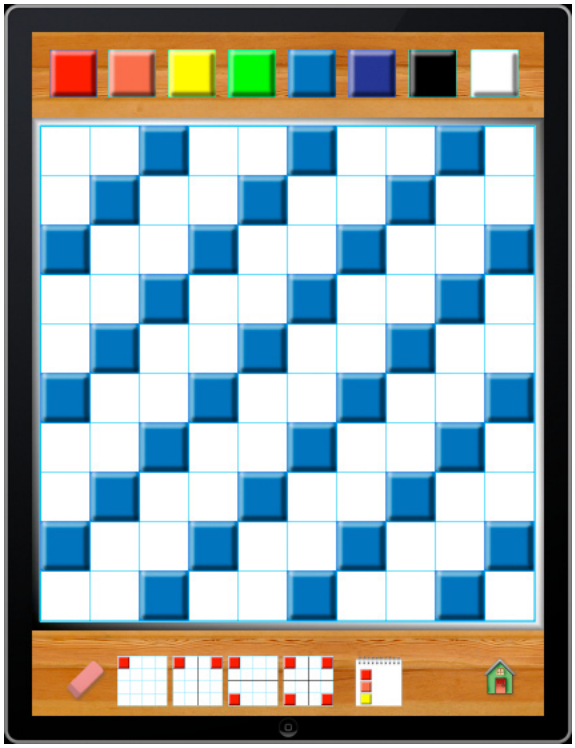


Making Designs with Color Tiles

Early Learning Experience

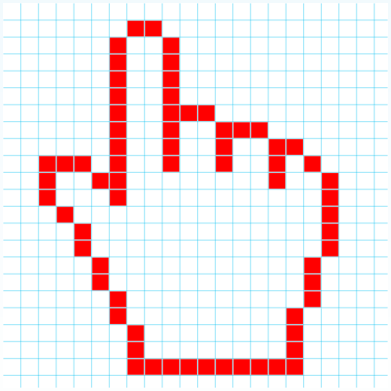
You can use the Color Tiles Playground to make many differents kinds of designs. Here are two examples.





Use the Color Tiles Playground to make a design. After you have finished your design count how many of each tile you used. Make a table in your notebook to show your answers. Tap the Chart icon to check your work.

Tap the Chart icon to display a report of how many of each Color Tile is on the Playground. The total is also displayed.

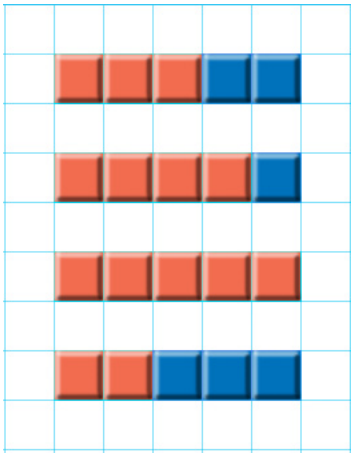


Exploring with Color Tiles

Expanding Basic Computational Skills

Use just blue and orange Color Tiles for this activity.

How many different ways can you make each sum? Use the Color Tiles Playground to find ways to make each sum. Write your answers in your notebook.



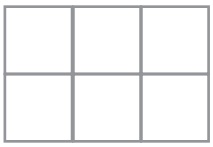
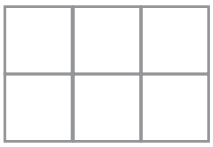
3 + 2 = 5

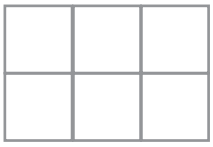
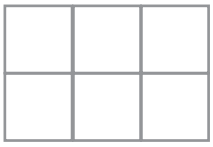
4 + 1 = 5

5 + 0 = 5

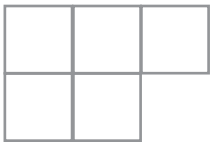
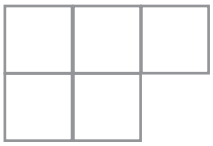
2 + 3 = 5

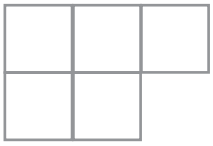
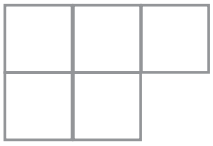
1.

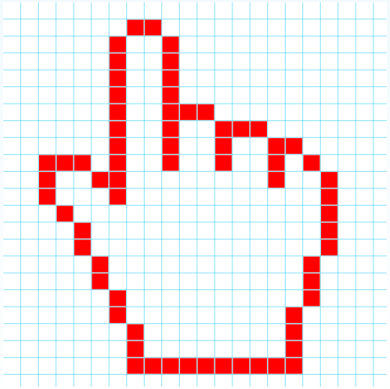
 + = 6  + = 6

 + = 6  + = 6

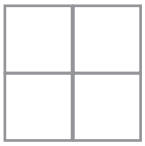
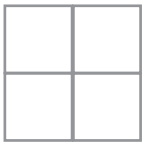
2.

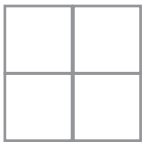
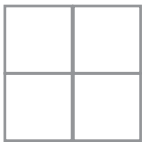
 + = 5  + = 5

 + = 5  + = 5



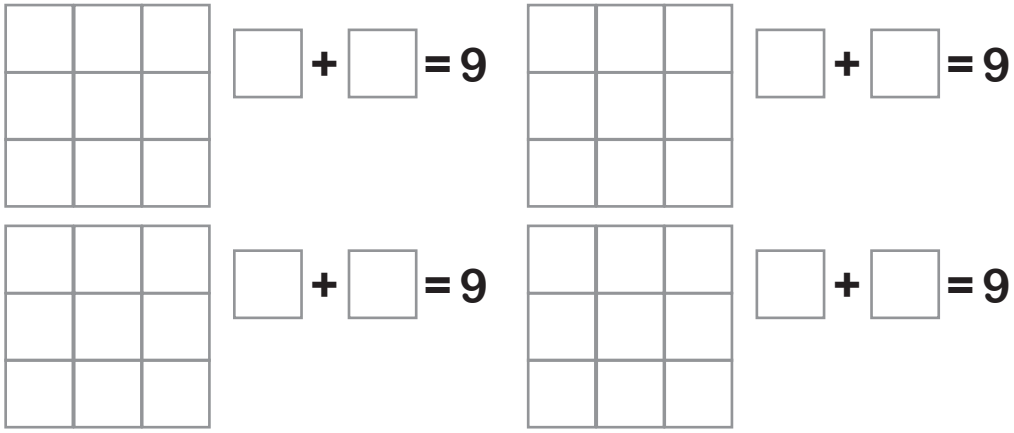
3.

 + = 4  + = 4

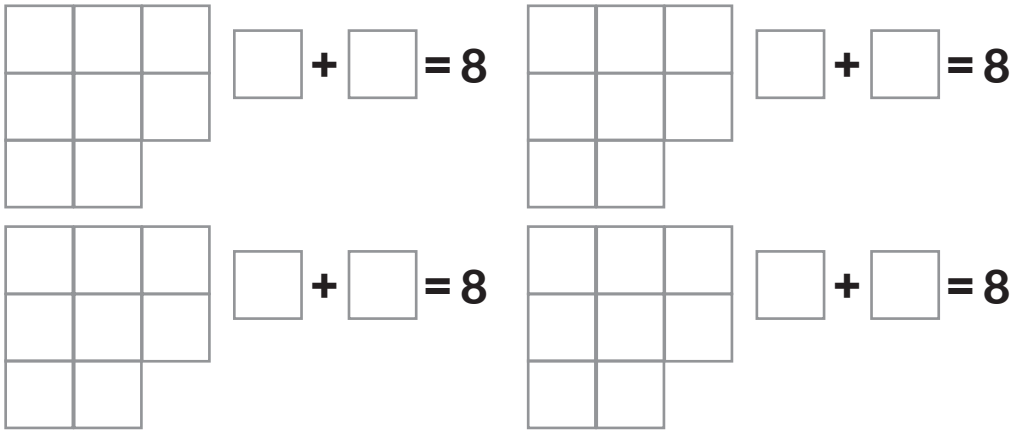
 + = 4  + = 4

Use just blue and orange Color Tiles for this activity. Find different ways to make each of the sums on this page.

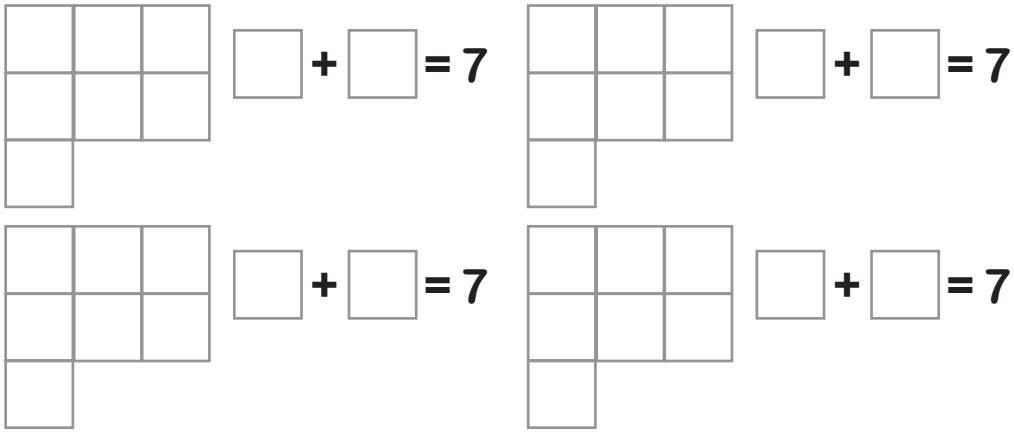
4.

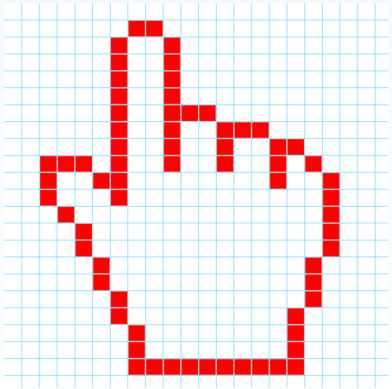


5.



6.

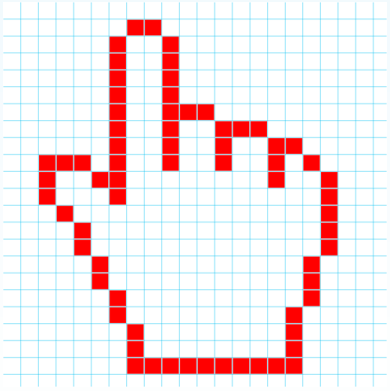




Missing Addends

Did you know that if you swipe your iPad with 4 fingers you can switch between open applications?

Use this to switch between Notes and Color Tiles.

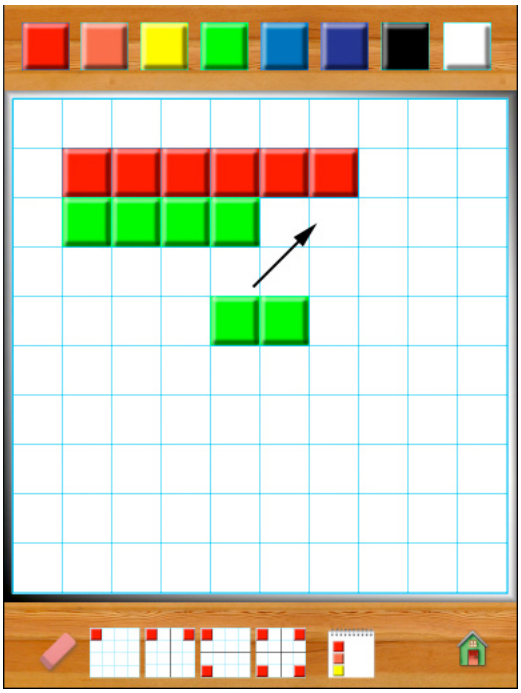


Expanding Basic Computational Skills

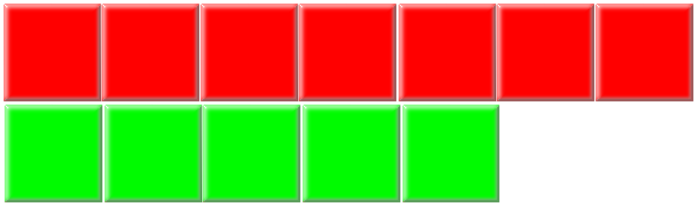
Use just red and green Color Tiles for this activity.

Put a group of red Color Tiles in a row to show the sum. In the next row show the first addend. Find the number of Color Tiles needed to make the two sets equal. Write the missing addend in your notebook.

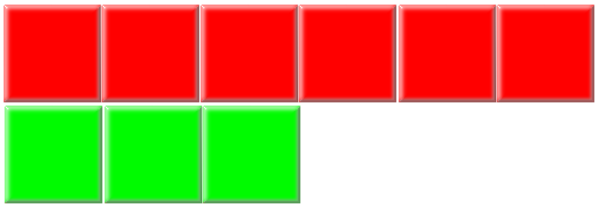
4 + 2 = 6



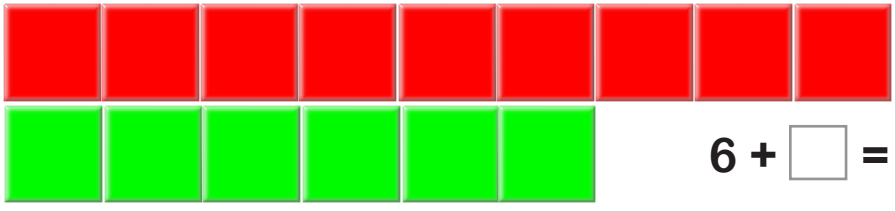
3 + ☐ = 7



5 + ☐ = 7



3 + ☐ = 6



6 + ☐ = 9

Missing Addends

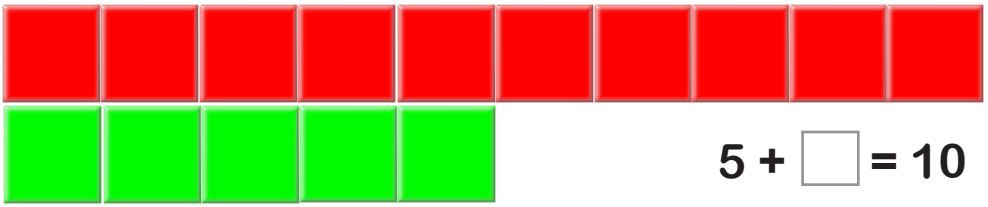
Expanding Basic Computational Skills

Find the missing addends for the problems on this page.

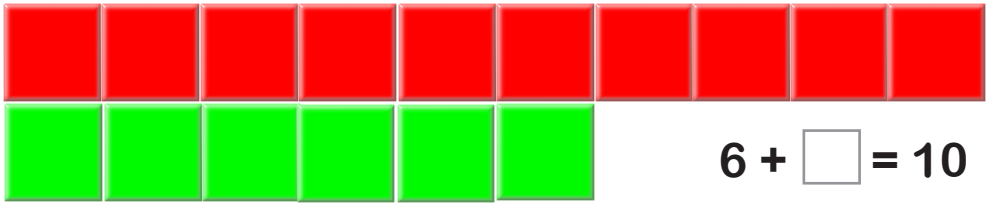
3 + ☐ = 10

4 + ☐ = 10

1 + ☐ = 10

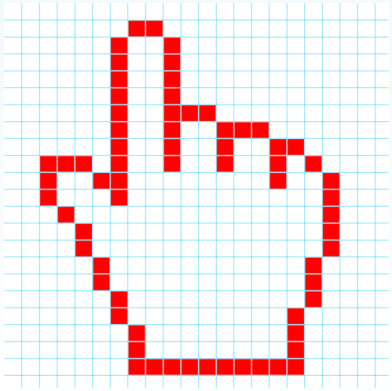


5 + ☐ = 10



6 + ☐ = 10

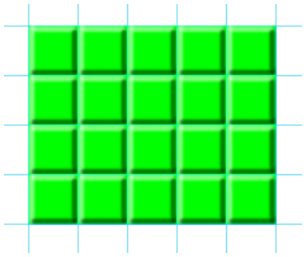
2 + ☐ = 10



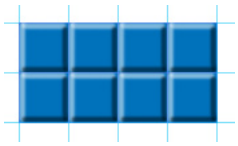
Multiplication with Color Tiles

In this example there are 5 color tiles in each row. There are 4 rows. How many Color Tiles are in the set?

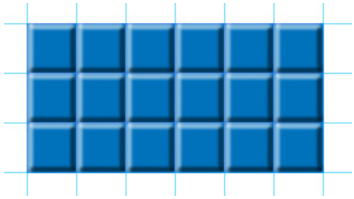
$5 \times 4 = 20$



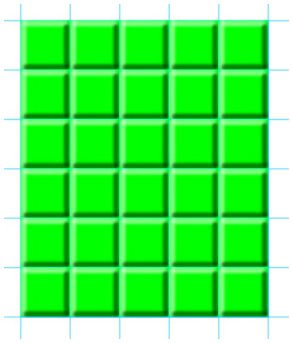
Use the Color Tiles Playground to make these arrangements of Color Tiles. Tell how many Color Tiles there are altogether. Write your answers in your notebook.

1. 

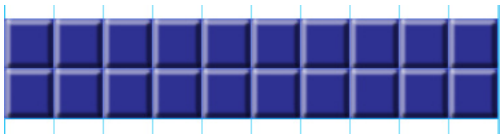
$2 \times 4 =$ ☐

2. 

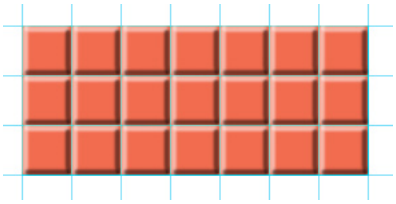
$3 \times 6 =$ ☐

3. 

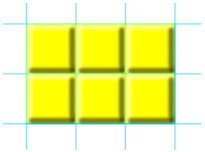
$6 \times 5 =$ ☐

4. 

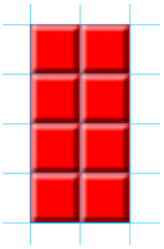
$2 \times 10 =$ ☐

5. 

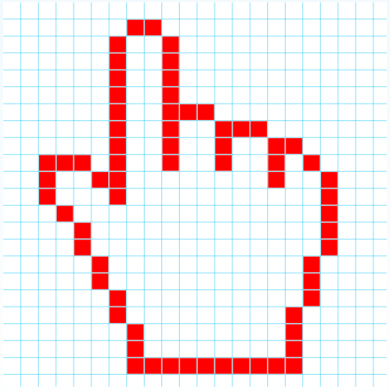
$3 \times 7 =$ ☐

6. 

$2 \times 3 =$ ☐

7. 

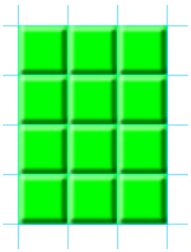
$4 \times 2 =$ ☐



Multiplication with Color Tiles

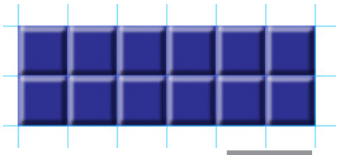
Use the Color Tiles Playground to make these arrangements of Color Tiles. Tell how many Color Tiles there are altogether. Write your answers in your notebook.

1.



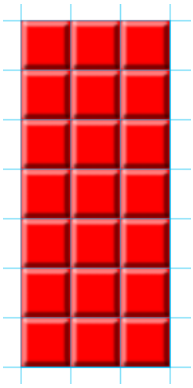
4 × 3 = ☐

2.



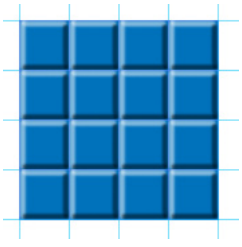
2 × 6 = ☐

3.



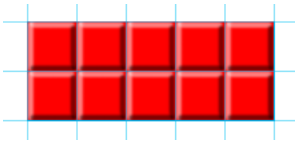
7 × 3 = ☐

4.



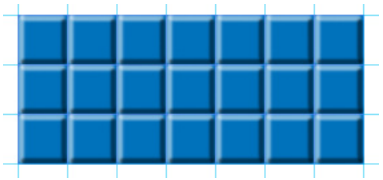
4 × 4 = ☐

5.



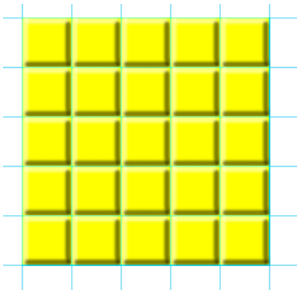
2 × 5 = ☐

6.



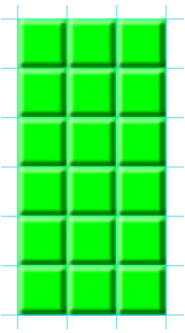
3 × 7 = ☐

7.

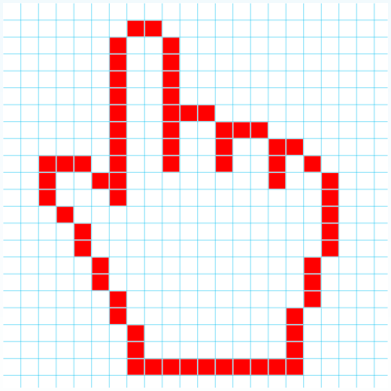


5 × 5 = ☐

8.

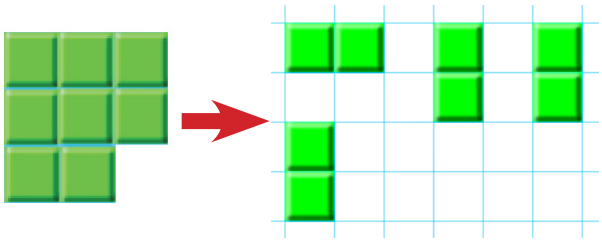


6 × 3 = ☐



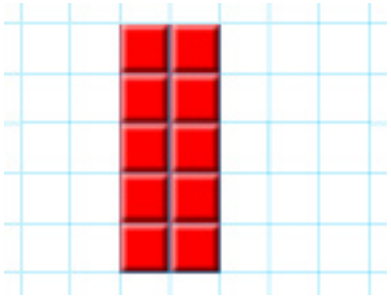
Division with Color Tiles

Division can be shown as a process of arranging a set of Color Tiles in equal groups. Here is one way to place 8 Color Tiles in groups with exactly 2 tiles in each group. This results in 4 groups.

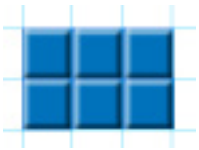


$8 \div 2 = 4$

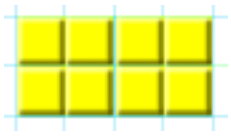
Use the Color Tiles Playground to find the answer to these division problems.

1. 

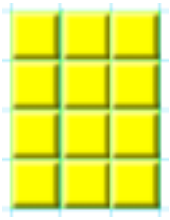
$10 \div 5 =$ ☐

2. 

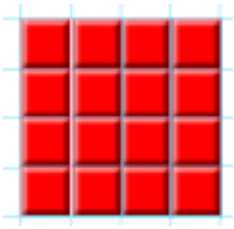
$6 \div 3 =$ ☐

3. 

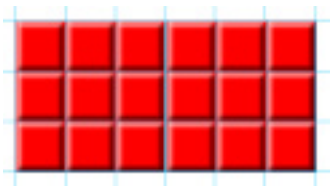
$8 \div 2 =$ ☐

4. 

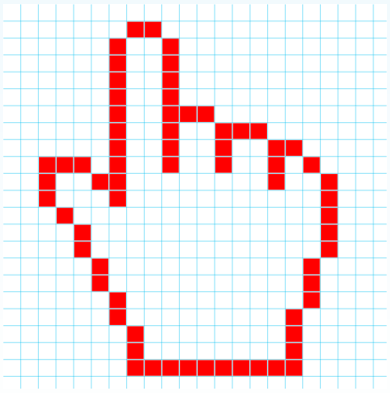
$12 \div 4 =$ ☐

5. 

$16 \div 2 =$ ☐

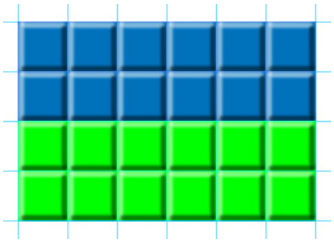
6. 

$18 \div 2 =$ ☐



Fractions with Color Tiles

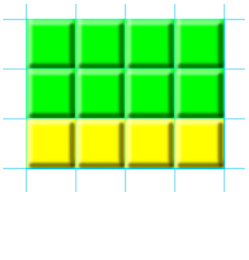
Here is a rectangle made from two different colors of Color Tiles.

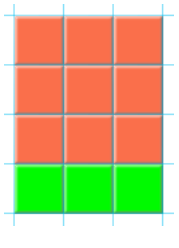


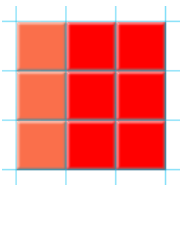
$\frac{1}{2}$ are blue

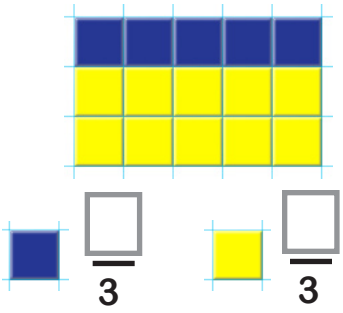
$\frac{1}{2}$ are green

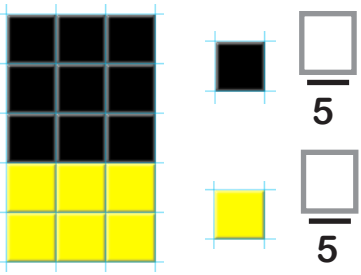
Place Color Tiles on the Playground to make a rectangle with the number of tiles given. Each rectangle represents two fractions. Write the fractions in your notebook for each example. Use the Chart to check your answers.

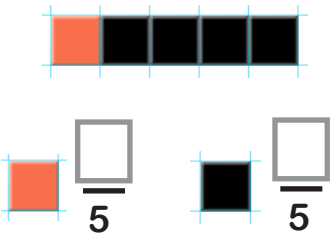
1. 

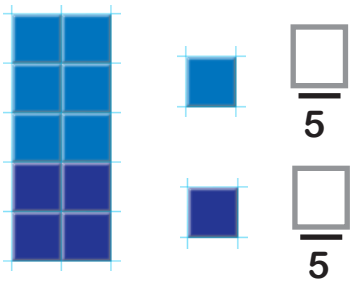
2. 

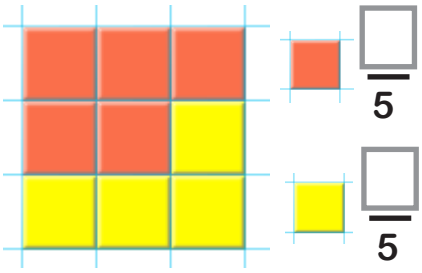
3. 

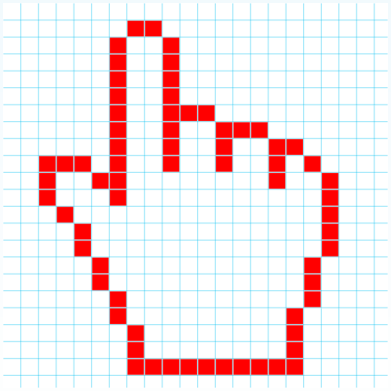
4. 

5. 

6. 

7. 

8. 

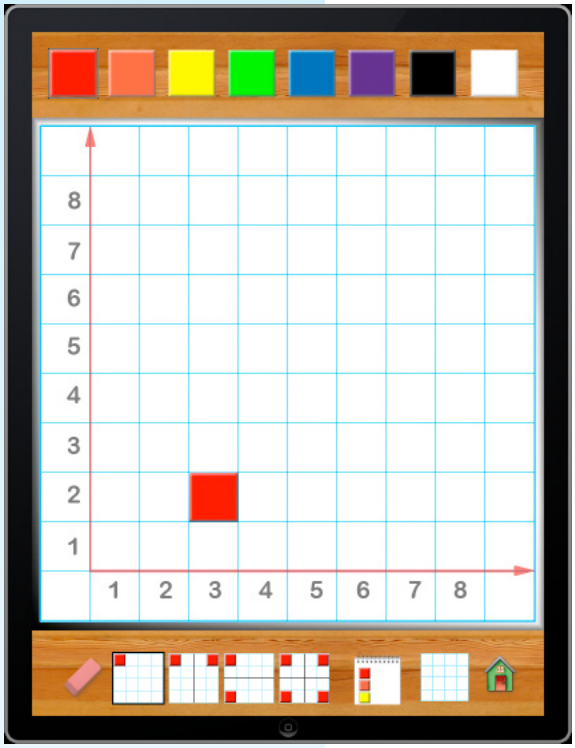


Building Concepts

Introducing Coordinate Pairs

In Settings the Grid Options should be set to 'On' so that grids can be displayed on the Playground. Tap the Grid icon once to display a grid showing Quadrant I of the Cartesian Plane.

The origin is the starting point for the grid. Points on the grid can be defined by two numbers that tell the distance from the origin. For example, the coordinate pair (3,2), defines a position that is 3 to the right of the origin and 2 up.



(3, 2) **(→, ↑)**

The red color tile is located at (3, 2).

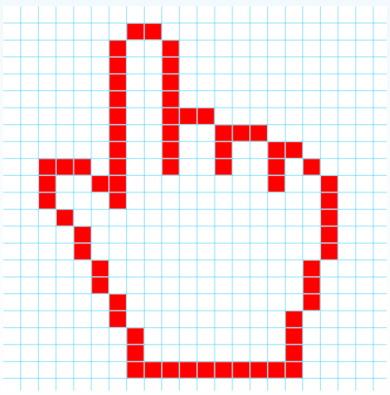
Place a green color tile at these positions:

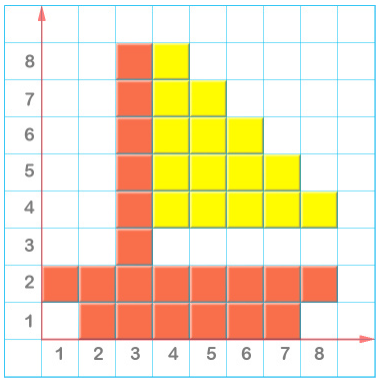
1. (3, 4)
2. (4, 3)
3. (5, 1)
4. (5, 2)
5. (5, 3)
6. (5, 4)
7. (5, 5)
8. (6, 4)
9. (7, 5)

Place a red color tile at these positions:

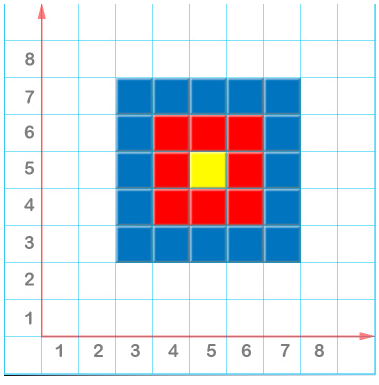
1. (3, 7)
2. (4, 6)
3. (4, 7)
4. (4, 8)
5. (5, 6)
6. (5, 7)
7. (5, 8)
8. (6, 6)
9. (6, 7)
10. (6, 8)
11. (7, 7)

Encourage students to make their own designs and record the coordinate pairs. Share the lists of coordinate pairs with other students in the group to practice locating points on a grid. Here are some ideas:





Sailboat



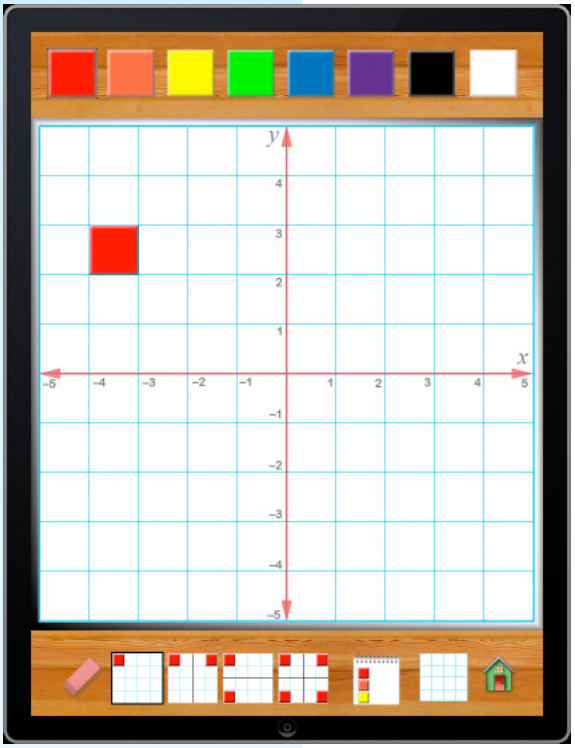
Design

Extending Ideas

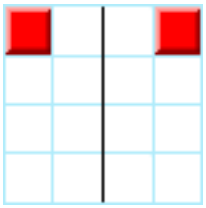
Reflecting on the Cartesian Plane

In Settings the Grid Options should be set to 'On' so that grids can be displayed on the Playground. Tap the Grid icon twice to display a grid showing the four quadrant Cartesian Plane.

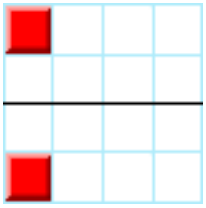
The origin is the starting point for the grid. The *x*-axis and *y*-axis divide the grid into four parts. Points are defined by two numbers that tell the distance from the origin. For example, the coordinate pair (-4,3), defines a position that is 4 to the left of the *y*-axis and 3 up from the *x*-axis.



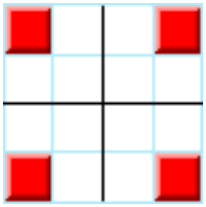
(-4, 3) (↔, ↕)



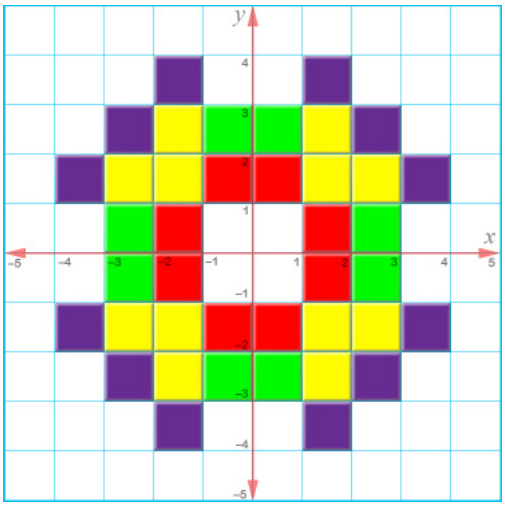
Use this grid option in combination with the mirrors to study reflections across the *y*-axis. When using the mirrors, new Color Tiles are reflected as they are placed on the Playground.



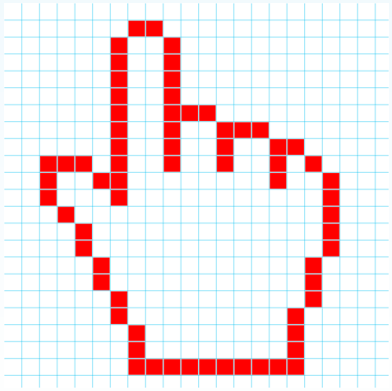
Use this grid option in combination with the mirrors to study reflections across the *x*-axis.



Use this grid option in combination with the mirrors to study reflections across both the *x*-axis and *y*-axis.



Explore the grid and mirror options. Make a design with Color Tiles.



Hands-On Math: Interactive Color Tiles

Ventura Educational Systems