Summary
This activity introduces children to sampling with replacement as a way to predict how many of each color are in a bag of color tiles.

Materials
Paper bags
Color tiles
Additional Resources
Math by All Means: Probability Grades 3-4 by Marilyn Burns
About Teaching Mathematics: A K-8 Resource, 2nd Edition by Marilyn Burns

## Background for Teachers

This activity engages children in taking samples and analyzing data, and provides them with opportunities to think proportionally. Students discuss and define words such as certain, impossible, likely, unlikely, 50/50 chance, etc.

Intended Learning Outcomes

1. Demonstrate a positive learning attitude toward mathematics.
2. Reason mathematically.

Instructional Procedures
Invitation to Learn
Show students a paper bag and tell them you have placed color tiles in the bag. (Put 12 tiles of the same color in the bag, for example: 12 yellow tiles). Walk around the room letting children look into the bag. After everyone has had a chance to see inside the bag, tell students you are going to shake the bag up, and without looking inside you will put your hand into the bag and take out one tile. Ask students to predict what color of tile they think you will pull from the bag. You should hear a chorus of YELLOW. Hold a discussion about why it would be yellow. Ask students how likely it would be that you would draw a yellow tile from the bag. Students might respond by saying it is very likely, extremely likely, highly likely, etc. If students do not say the word CERTAIN, add that to the discussion. Tell students there is a numerical way to write the chance of pulling a yellow tile from the bag; write 12 out of 12 . Then write 12/12 and say "12 out of 12. " Then write $12: 12$ and say "12 to 12. " Instructional Procedures

Write the words "Certain" and "Impossible" on the board, each on one end of a vertical line. Do not write very likely, likely, 50/50 chance, etc. Discuss these words and let students tell you where to place them on the line.

Ask a student to help you place an X on the line between "Certain" and "Impossible" that would display the chance of pulling a yellow tile from the bag.
Now take one yellow tile out and put in one red tile. Again walk around the room letting students look into the bag. Again ask students to predict what color of tile they think you will pull from the bag if you were to shake it up and randomly draw one tile.
Ask students if they can tell you the numerical way to write the chance of pulling a red tile from the bag (1out of 12; 1/12; 1out of 12, etc.) Write these on the board as students dictate them.
Fill in the chart by adding the words likely and unlikely, 50/50 chance and then very likely and very unlikely, discussing with students the placement of each phrase.

Continue changing the make-up of tiles in the bag. Start by adding one or two of another color and taking out one or two of the original color. For now, only use two colors. Keep the discussion on the number of tiles and the number of each color. Each time you take a tile, write the numerical display in several ways on the board, saying it out loud.
Now put 12 tiles in a bag (example: 8 red and 4 yellow). Tell students you have 12 tiles of two different colors. Explain that you are going to pull one tile at a time from the bag without looking inside. Write a T-chart on the board with RED and YELLOW for the headings. Put a tally mark under the color you drew out. Have students take turns pulling out one tile at a time and replacing it back into the bag. Explain to students you are conducting a "sampling with replacement" experiment. Each time, record what color was taken from the bag. After 12 times, ask students if they can predict how many of what color tiles are in the bag. Students should be able to predict different combinations that add up to 12 ( 11 red, 1 yellow; 10 red, 2 yellow, etc.) Have students write their prediction on paper. Continue to draw 12 more tiles, one at a time, from the bag recording the color of tile on the T-chart. Again ask students to predict how many of what color tiles are in the bag. Explain to them that they now have more information than they did after just 12 draws to help them formulate their prediction. Again have students write their new prediction under their first prediction. Draw 12 more tiles, recording them on the board in the T-chart. Lead a discussion about what tiles students think are in the bag now. Have their predictions changed from the first one? Why? Remind students you are conducting an experiment by "sampling with replacement." Have students write a prediction of the contents in the bag by completing the sentence: I think there are $\qquad$ yellow tiles and $\qquad$ red tiles in the bag because...
Curriculum Integration
Math/Science--Read Probably Pistachio by Stuart Murphy. This is the story of Jack a young boy who thinks nothing is going his way. Will he get what he wants in his lunch? Probably not! This story centers on probability and Jack's chances of things going his way.

## Extensions

## Possible Extensions/Adaptations

Pair up students. Have each pair put 12 tiles of two different colors into a bag, discussing their choices. Have partners trade their bag with another pair. Partners conduct an experiment by sampling with replacement. After 12 draws, have students record their predictions of how many of each color tile are in the bag. Students then draw 12 more times, making another prediction and explaining their thinking in a paragraph. Finally, have students dump the contents of the bag to reveal the correct combination of color tiles.
Homework \& Family Connections
Have students conduct an experiment at home similar to the one done in class. Students gather two different items to put in a paper bag in varying quantities. For example: 4 matchbox cars and 3 fingerboards (toy skateboards). Next, students can sit with a family member and assist them in randomly selecting one item at a time from the bag (without looking at the contents). The student explains how to record their choice on a T-chart. The student (or family member) continues selecting items from the bag, recording it on their chart, and then replacing it. Instruct students to select items and replace them at least 12 times. Students then ask their family member to predict the contents of the bag after considering the results on their T-chart. This activity has many possibilities for length (number of draws from the bag) and options for selecting items to go into the bag. After the family member has completed the activity, ask them to write a short paragraph explaining their thoughts or feelings. Students can share responses with class the following day.

Students should keep a log of what happened in their experiment. They can use the T-chart or construct their own way of displaying the information they gathered. After they have completed the assigned number of pulls from the bag and recorded their results, ask students to discuss these questions with their partner.

How likely is it to pull a yellow tile from the bag when there are 12 yellow and 0 red? How likely is it to pull a yellow tile from the bag when there are 11 yellow and 1 red? How likely is it to pull a yellow tile from the bag when there are 10 yellow and 2 red? How likely is it to pull a yellow tile from the bag when there are 2 yellow and 10 red? How likely is it to pull a yellow tile from the bag when there are 1 yellow and 11 red? How likely is it to pull a yellow tile from the bag when there are 3 yellow and 9 red? How likely is it to pull a yellow tile from the bag when there are 7 yellow and 5 red? Ask students to write their explanation to the following questions and be prepared to share their responses in a class discussion:

What words or numerical display on the chart describe the chance of pulling a yellow tile from the bag when there are 12 yellow tiles and 0 red tiles? Explain how you know this.
What words or numerical display describe the chance of pulling a yellow tile from the bag when there are 6 yellow and 6 red tiles? Explain your answer.

## Authors

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