

# The Game of Chance

*Angela Han*

*S. Weir Mitchell Elementary School*

## **Overview**

## **Rationale**

## **Objectives**

## **Strategies**

## **Classroom Activities**

## **Bibliography**

## **Appendices**

### **Overview:**

The goal of this curriculum unit is to develop students' understanding of probability and chance. It is designed to develop the students' vocabulary related to probability, and allow students to become comfortable with talking about chance events. It will introduce many probability expressions such as *sure, certain, probably, 50-50 chance, not likely, impossible*, and others. In addition, the students will explore how probability affects various situations by performing probability experiments, and they will learn to represent the data from chance events explorations in graphs and tables. Through continual use of this vocabulary in explorations, the students will progressively make them part of their repertoire. Students will be able to:

1. Make informal comparisons between the chances of various outcomes of an event.
2. Make predictions by comparing the likelihood of two possible outcomes.
3. Explore equally likely outcome events through experimentation.

This unit is intended to complement the School District of Philadelphia's pre-existing curriculum (*Everyday Math*). The allotted time for this unit is 15 days spread throughout the year. Its audience is third grade students in a low to mid-income urban neighborhood.

### **Rationale:**

Probability is one of the most important subjects to be taught because of its pervasiveness in our society. It is used every day, in almost every capacity of daily existence. We are faced daily with situations where a proper understanding of probability is crucial, such as weather reports, investments, and our health. We do not act blindly to get what we want. Our actions also depend on how likely the desired outcome is (Schlottmann 2001). When

we make decisions on if we should spend an extra \$100 on a warranty for a washer, we use our knowledge of how likely the washer will breakdown to form our decision.

Young children need to explore the process of probability. The study of probability in the early grades provides a stronger foundation for high school students (NCTM, 2000). By studying probability, children make sense of experiences involving chance. Beginning in the elementary grades, students should be taught experimental probability concepts, yet that does not always happen. Even though probability is rich in class participatory activity material and the amount is infinite, as a class progresses through the school system, and content delivery for examinations becomes a priority, this kind of activity tends to be held back. This is truly disappointing as it can actually enrich and motivate a child's learning (Fisher 2005).

The School District of Philadelphia (SDP) uses Everyday Math as their math curriculum, which is a spiral curriculum that begins with fundamentals that children already have learned and builds upon them by adding more complex and subtle categories and methods. Even though probability is such a major part of our daily lives, SDP only dedicates a few lessons sporadically throughout the school year in their 3<sup>rd</sup> grade's Planning and Scheduling Timeline, briefly grazing the topic. Thus, teachers need to supplement the curriculum with more opportunities to help students develop the necessary skills.

### **Objectives:**

The objectives of this probability unit include the following:

- Build new mathematical knowledge through experimenting.
- Explore and justify solutions.
- Classify events using basic probability terms such as *sure* and *not sure*.
- Describe certain and uncertain events using expressions such as *good chance*, *likely*, *unlikely*, and *impossible* to discuss and compare the likelihood of events.
- Develop intuition about equally likely events.
- Collect and interpret data from experiments with outcomes that are equally likely and not likely to happen.

### **Strategies:**

The strategies that are the most conducive to a third grade classroom are: examination, exploration, and application. These strategies will be a springboard for the critical thinking that is the emphasis of this unit. They can be explained as follows:

1. Examination

Students examine how probability affects everyday situations in their lives and in read alouds (*It's A Penny* by Loreen Leedy, *A Million Fish...More or Less* by Patricia C. McKissack, *A Very Improbable Story: A Math Adventure* by Edward Einhorn, and *Probably Pistacho* by Stewart J. Murphy).

2. Exploration

Students discover how probability affects various circumstances by conducting probability experiments and collect, organize, and display data using tables, charts and graphs.

3. Application

Students apply what they have learned by using basic probability terms in everyday situations and designing probability games.

**Classroom Activities:**

Note: Each lesson is a 45 minute period.

- Lesson 1: Introduce the terms with everyday situations: *sure to happen, sure not to happen or may happen, but not sure*
- Lesson 2: Coin-toss experiment
- Lesson 3: Two marbles experiment
- Lesson 4: Three marbles experiment
- Lesson 5: Four marbles experiment
- Lesson 6: Paper Bags with Color Tiles Experiment
- Lesson 7: Spinner experiment (even division)
- Lesson 8: Spinner experiment (uneven division)
- Lesson 9: One die experiment
- Lesson 10: Two dice experiment
- Assessment (Lessons 11, 12, 13, 14, 15): Students will play various probability games and then design their own probability games with spinner, dice, marbles, or coins.

Sample Lesson Plan #1 (Introduction to Probability)

Objectives:

With 80% accuracy, students will learn:

- Classify events using basic probability terms such as *sure* and *not sure*.
- Describe certain and uncertain events using expressions such as *good chance, likely, unlikely, and impossible* to discuss and compare the likelihood of events.

PA Mathematics Standards:

- 2.7.3.A. Predict and measure the likelihood of events and recognize that the results of an experiment may not match predicted outcomes.

Materials:

- *It's A Penny* by Loreen Leedy
- *A Million Fish...More or Less* by Patricia C. McKissack
- Math notebook
- “Vocabulary for Chance Events” Chart (Appendix 1)
- *A Million Fish...More or Less* worksheet (Appendix 2)
- “Likely and Unlikely Event” worksheet (Appendix 3)

Plans:

1. Introduction (15 minutes)
  - a. Read *It's A Penny* by Loreen Leedy.
  - b. Pose the questions:
    - i. What is one thing that you are *sure will happen* this week?
    - ii. What is one thing that you are *sure will not happen* this week?
    - iii. What is one thing that *may or may not happen* this week?
  - c. Have students record their responses in their math notebook.
  - d. Display a t-chart. Write *Sure* and *Not Sure* above the columns. Have the students share some of their answers and record them in the appropriate columns.
2. Lesson (20 minutes)
  - a. Explain:
    - i. Events are things that happen. Among events that are uncertain, some are very likely to happen, others are less likely to happen. Many everyday expressions are used to describe the likelihood of an event.
  - b. Discuss the “Vocabulary for Chance Events” Chart.
  - c. Ask the students to restate some of the events in the *Not Sure* column (t-chart from introduction), using various expressions that describe uncertainty.
  - d. Compare the likelihood of two or more events listed in the *Not Sure* column. Ask:
    - i. *Are some events more likely to happen than others?*
    - ii. *Are some events equally likely to happen?*
  - e. Have students label one page of their math notebook: “Sure Will Happen.” Then tell students to write two events that fit this category.
  - f. Have students label another page of their math notebook: “Sure Will Not Happen.” Then tell students to write two events that fit this category.
  - g. Have students label one page of their math notebook: “Might Happen.”

Then tell students to write two events that fit this category.

**Note:** Add to these lists throughout the unit.

3. Wrap Up (10 minutes)
  - a. Read *A Million Fish...More or Less* by Patricia C. McKissack. Have students complete the *A Million Fish...More or Less* worksheet.
4. Homework: “Likely and Unlikely Event” worksheet

### Sample Lesson Plan #2 (Coin Toss)

#### Objectives:

With 80% accuracy, students will learn:

- Develop intuition about equally likely events by performing a coin-toss experiment.
- Collect and interpret data from experiments with outcomes that are equally likely and not likely to happen.

#### PA Mathematics Standards:

- 2.7.3.A. Predict and measure the likelihood of events and recognize that the results of an experiment may not match predicted outcomes.
- 2.7.3.C. List or graph the possible results of an experiment.
- 2.6.3.A. Gather, organize and display data using pictures, tallies, charts, bar graphs, and pictographs.

#### Materials:

- chart paper labeled “Probability – Class Chart”
- markers
- 10 coins for each pair of students
- “Coin-Toss Experiment” worksheet (Appendix 4)
- Interactive White Board
- *Everyday Mathematics (Grade 3) – HomeLinks 4.10*

#### Plans:

1. Introduction (10 minutes)

**Note:** Have the chart paper labeled “Probability – Class Chart” and marker ready to write down students’ predictions.

  - a. Show the students a quarter. Ask students questions to identify it:
    - i. *What is it?*
    - ii. *How is it used?*
    - iii. *Describe how it looks.*
  - b. Ask the students whether they have seen a coin toss used to decide the order of play for games. Remind them that a coin has two different sides – heads and tails. Have a volunteer demonstrate how to toss a coin to decide

the order of play.

- c. Pose the question:
  - i. *Can you predict what would happen if the coin is tossed?*
- d. Once they determine it will either come up heads or tails ask:
  - i. *What is the probability of the coin coming up on heads and/or tails?*

2. Lesson (25 minutes)

- a. Tell students that they are going to conduct a coin-toss experiment to determine whether heads and tails are equally likely.
  - i. Coin Toss Directions: Partners share 10 coins. They take turns tossing all 10 coins 5 times. For each turn, they shake 10 coins and drop them about one foot above a surface. Students count the number of coins landing heads up and the number landing tails up. They each record the results for their own coin tosses on the table at the top of “Coin-Toss Experiment” worksheet.
- b. Have students calculate the total number landing heads up from all five tosses and the total number landing tails up. Ask them to check their calculations by adding the two totals: (total heads up) + (total tails up) should equal 50. Have students record the class totals on the “Coin-Toss Experiment” worksheet.
- c. Have the partnerships combine totals for heads and tails. The combined number should equal 100. Have students record the class totals on the “Coin-Toss Experiment” worksheet.
- d. Have each partnership call out the numbers of heads and tails for their 100 tosses. Record the results on the board in a t-chart.
- e. Use calculators to find the total number of heads and the total number of tails for the entire class. Have students record the class totals on the “Coin-Toss Experiment” worksheet.
- f. The class totals should show nearly equal numbers of heads and tails, confirming the students’ intuition that these results are equally likely. Help students summarize the results on the “Probability – Class Chart.” Use language such as: “We got nearly equal numbers of heads and tails,” “Heads and tails are equally likely,” and “You get heads on 1 out of 2 tosses if you toss a lot.”

3. Wrap Up (10 minutes)

- a. Using the Interactive Whiteboard link to the virtual coin toss on <http://pbskids.org/cyberchase/games/probability/cointoss.html>
- b. Confirm the class results by tossing a virtual coin a chosen number of times. Through the virtual experience students will confirm that the more times the coin is tossed, the more probability the coins’ face would have an equally likely chance of landing on heads or tails.

4. Homework: *Everyday Mathematics (Grade 3) – HomeLinks 4.10*

### Sample Lesson Plan #3 (Two Marbles Experiment)

#### Objectives:

With 80% accuracy, students will learn:

- Develop intuition about 50-50 chance events by performing a two marbles experiment.
- Collect and interpret data from experiments with outcomes that are equally likely and not likely to happen.

#### PA Mathematics Standards:

- 2.7.3.A. Predict and measure the likelihood of events and recognize that the results of an experiment may not match predicted outcomes.
- 2.7.3.C. List or graph the possible results of an experiment.
- 2.6.3.A. Gather, organize and display data using pictures, tallies, charts, bar graphs and pictographs.

#### Materials:

- *Probably Pistachio* by Stewart J. Murphy
- “Probability – Class Chart” from the Coin Toss lesson
- Two Marbles worksheet (Appendix 5)

#### Plans:

1. Introduction (10 minutes)
  - a. Read *Probably Pistachio* by Stewart J. Murphy.
  - b. Review the “Probability – Class Chart,” and discuss equally likely events.
2. Lesson (25 minutes)
  - a. Explain that probability can change when using more than two things. Tell students that they are exploring the possibilities of two marbles in a bag using online simulations.
  - b. Hand out Two Marbles worksheet. Model and explain the directions on the worksheet.
3. Wrap Up (10 minutes)
  - a. Discuss students’ findings and put more probability findings on the “Probability – Class Chart.”
4. Homework: Write a paragraph explaining how the coin-toss experiment and the Two Marbles experiment are similar.

### Sample Lesson Plan #4 (Paper Bag with Color Tiles)

#### Objectives:

With 80% accuracy, students will learn:

- Use paper bags with color tiles to calculate probability of colors.
- Collect and interpret data from experiments with outcomes that are equally likely and not likely to happen.

PA Mathematics Standards:

- 2.7.3.A. Predict and measure the likelihood of events and recognize that the results of an experiment may not match predicted outcomes.
- 2.7.3.C. List or graph the possible results of an experiment.
- 2.7.3.D. Analyze data using the concepts of largest, smallest, most often, least often and middle.
- 2.6.3.A. Gather, organize and display data using pictures, tallies, charts, bar graphs and pictographs.

Materials:

- *A Very Improbable Story: A Math Adventure* by Edward Einhorn
- Bag A – 4 red and 4 green tiles
- Bag B – 4 blue and 4 yellow tiles
- Bag C – 2 red, 2 green, 2 blue, 2 yellow
- Bag D – 3 red, 3 blue, 1 green, 1 yellow
- Bag E – 1 red, 1 blue, 2 green, 4 yellow
- Bag F – 1 red, 3 blue, 3 green, 1 yellow
- Chart for tallying the colors (one for each group)
- Red, Blue, Green, Yellow Crayons
- Probability worksheet (Appendix 6)

Plans:

1. Introduction (5 minutes)
  - a. Talk to the class about predicting in stories and what that means. Then explain that they will use the "Power of Prediction" to guess what color the tiles in the bags are.
2. Lesson (30 minutes)
  - a. Post the various tile combinations in the bags on the board, and tell that they are experimenting today to predict which tile combination matches their bag.
  - b. Demonstrate the experiment by taking Bag A and blindly choose one tile at a time from the bag. Write the result on the class tally chart. Do this a few times.
  - c. Divide the class into six teams and give them the bags and tallying charts.
  - d. Have the students blindly choose one tile at a time from their bag and tally the result. They then put the tile back in and choose again, repeating this for 50 times.
  - e. At the end of the 50 times, they graph their tally marks and make

- predictions about the colors of tiles in their bags.
3. Wrap Up (10 minutes)
    - a. Have each group explain their predictions and open the bag to reveal the combination of tiles in the bag.
  4. Homework: Probability worksheet.

### **Bibliography:**

Fisher, Ian. "Maths Resource Good Luck?" Mathematics in School. Jan. 2005.

National Council of Teachers of Mathematics (NCTM). Principle and standards for school mathematics. Reston, VA: NCTM, 2000.

Pennsylvania Department of Education. "Academic Standards for Mathematics." 22 Pennsylvania Code, Chapter 4, Web. 30 June 2011.

Scholottmann, Anne. "Children's Probability intuitions: Understanding the Expected Value of Complex Gambles." Child Development, Jan/Feb 2001.

### **Resources:**

Basic concepts of Certain, Probable, Unlikely, Impossible #1:  
<http://www.free-training-tutorial.com/math-games/probability-basics.html?1&>

Basic concepts of Certain, Probable, Unlikely, Impossible #2:  
<http://www.kidsmathgamesonline.com/numbers/probability.html>

Coin Toss: <http://pbskids.org/cyberchase/games/probability/cointoss.html>

Fish Tank:  
<http://www.free-training-tutorial.com/math-games/probability-fish-tank.html?1&>

Marble Mania: <http://www.sciencenetlinks.com/interactives/marble/marblemania.html>

Probability Quiz:  
<http://www.newbedford.k12.ma.us/elementary/gomes/stjohn/Subjects/Math/Probability/Probability1.html>

## Appendix 1

<b>Vocabulary for Chance Events</b>	
sure will happen	for sure, unavoidable, absolutely, must
uncertain, not sure	very likely, almost surely, likely, good chance, probably, toss-up, 50-50 chance, possibly, not likely, poor chance, very unlikely
sure will not happen	impossible, no way, can't happen

**Appendix 2**

Name: \_\_\_\_\_

Date: \_\_\_\_\_

Grade: \_\_\_\_/Room: \_\_\_\_\_

*A Million Fish...More or Less*

**Directions:** Listen to the story *A Million Fish...More or Less*. Circle the box that shows how likely each event in the book is.

1. How likely is it that the wild turkey weighed 500 pounds?

very unlikely	unlikely	likely	very likely
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2. How likely is it that Hugh is about 8 years old?

very unlikely	unlikely	likely	very likely
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3. How likely is it that Hugh had mosquitoes for company?

very unlikely	unlikely	likely	very likely
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4. How likely is it that Hugh caught a million fish?

very unlikely	unlikely	likely	very likely
---------------	----------	--------	-------------

5. How likely is it that pirate treasure was hidden among the cypress trees?

very unlikely	unlikely	likely	very likely
---------------	----------	--------	-------------

6. Write your own.

\_\_\_\_\_

very unlikely	unlikely	likely	very likely
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**Appendix 3**

Name: \_\_\_\_\_

Date: \_\_\_\_\_

Grade: \_\_\_\_/Room: \_\_\_\_\_

**Likely and Unlikely Event**

**Directions:** Tell whether each event below is *sure to happen*, *sure not to happen*, or *may happen, but not sure*. Circle the answer.

1. You will grow taller next year.

sure to happen	sure not to happen	may happen, but not sure
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2. You will like to be 200 years old.

sure to happen	sure not to happen	may happen, but not sure
----------------	--------------------	--------------------------

3. You will watch TV next Saturday.

sure to happen	sure not to happen	may happen, but not sure
----------------	--------------------	--------------------------

4. You will travel to the moon.

sure to happen	sure not to happen	may happen, but not sure
----------------	--------------------	--------------------------

5. You will sleep tonight.

sure to happen	sure not to happen	may happen, but not sure
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**Appendix 4**

Name: \_\_\_\_\_

Date: \_\_\_\_\_

Grade: \_\_\_\_\_/Room: \_\_\_\_\_

**Coin-Toss Experiment**

**Directions:** You will each toss all 10 coins 5 times. For each toss you make, record the number of “heads” and the number of “tails” in the table.

<b>Toss Record</b>		
<b>Toss (10 coins)</b>	<b>Heads</b>	<b>Tails</b>
1		
2		
3		
4		
5		
<b>Total</b>		

**Directions:** Use the information in both your partner’s and your tables to fill in the blanks below.

My total: Heads: \_\_\_\_\_ Tails: \_\_\_\_\_

My partner’s total: Heads: \_\_\_\_\_ Tails: \_\_\_\_\_

Our partnership total: Heads: \_\_\_\_\_ Tails: \_\_\_\_\_

**Directions:** Record the number of Heads and the number of Tails for the whole class.

Number of Heads: \_\_\_\_\_

Number of Tails: \_\_\_\_\_

**Appendix 5**

Name: \_\_\_\_\_

Date: \_\_\_\_\_

Grade: \_\_\_\_/Room: \_\_\_\_\_

**Two Marbles**

**Directions:** For this activity, you will use the interactive marble simulation on the computer to repeat the lesson's first marble experiment that was conducted with only two marbles in the box. Follow these steps to repeat the experiment:

1. Go to: <http://www.sciencenetlinks.com/interactives/marble/marblemania.html>
2. Put "1"s in the boxes by the red and blue marbles and "0"s in the boxes by the yellow and green marbles.
3. Select "1" marble to draw (per trial).
4. Type in "10" in the Trials box.
5. Click on the "Run Trials" button.
6. Write your results in the box below and then click on the "Clear Trial" button.
7. Now do the same experiment, but use 50, 100, 500.
8. Write your results in the boxes below for each trial.

**Results for one-in-two (or 50%) chance of picking the red marble or the blue marble**

Number of Trials	% of Times Red is Picked	% of Times Blue is Picked
10		
50		
100		
500		

What do you notice about the marble runs in which you do more trials?

What do you think would happen if you ran 1,000 trials?

**Appendix 6**

Name: \_\_\_\_\_

Date: \_\_\_\_\_

Grade: \_\_\_\_\_/Room: \_\_\_\_\_

**Probability****Directions:** Answer each question.

1. If one letter is chosen at random from the word <i>possess</i> , what is the probability that the letter chosen is the letter "s"?  ____ out of <u>7</u>	2. A number cube has 6 sides. The sides are numbered 1 to 6. If the cube is thrown once, what is the probability of rolling the number 6?  ____ out of <u>6</u>
3. A bag contains 4 yellow marbles, 10 blue marbles, 12 purple marbles, 7 red marbles, and 11 green marbles. What is the probability of pulling out a yellow or a green marble?  <u>15</u> out of ____	4. A number cube has 6 sides. The sides have the numbers 6, 7, 3, 3, 6, and 2. If the cube is thrown once, what is the probability of rolling an even number?  <u>3</u> out of ____
5. If one letter is chosen at random from the word <i>businessmen</i> , what is the probability that the letter chosen is the letter "e"?  <u>2</u> out of ____	6. If one letter is chosen at random from the word <i>palate</i> , what is the probability that the letter chosen is the letter "a"?  ____ out of <u>6</u>
7. A number cube has 6 sides. The sides have the numbers 5, 4, 9, 5, 5, and 5. If the cube is thrown once, what is the probability of rolling the number 9 or the number 5?  ____ out of <u>6</u>	8. If one letter is chosen at random from the word <i>beaded</i> , what is the probability that the letter chosen is the letter "e"?  ____ out of <u>6</u>
9. A bag contains 2 red marbles, 11 yellow marbles, 6 blue marbles, 3 green marbles, and 13 purple marbles. What is the probability of pulling out a blue marble?  ____ out of <u>35</u>	10. If one letter is chosen at random from the word <i>prism</i> , what is the probability that the letter chosen is the letter "i"?  <u>1</u> out of ____