Fat Chance

By ***Fran Baldwin,*** for Blue Ridge Public Television (WBRA,WMSY,WSBN)
Riverlawn Elementary, Radford,VA

Grade Levels: 3-5

Time Allotment: Two 45-min. class periods

Overview: The purpose of this lesson is to begin the process of helping students to learn the basic principles of probability. Probability is a way of measuring the chance of something happening. The theory of probability is an important branch of mathematics, and an understanding of this theory is essential to understand weather reports, political doings, scientific research, and the state lotteries. Through a series of hands on games and activities the students will investigate this theory and have an opportunity to predict the possible outcomes for a specific event, construct a bar graph, and interpret the data.

Subject Matter: Math/Probability

Learning Objectives:

The objectives listed may be used in part to address the Virginia Standards of learning at http://www.pen.k12.va.us

The student will be able to:

- investigate and understand the concept of probability as chance (VA SOLs Math 2.23, 3.23, 4.18)
- list possible outcomes of a given situation (VA SOLs Math 3.23,)
- collect and use data to construct a simple bar graph (VA SOLs Science 3.1, 4.1, 5.1)
- write a proper fraction for a given set or part of a whole and use it to determine the probability

Media Components:

Video

- *Understanding Probability and Odds:* "Baye's Theorem Considering New Information When Making Decisions" http://www.unitedstreaming.com

- *Mathica's Mathshop:* "A Bundle of Joy", # 110
  This video is also available on http://www.unitedstreaming.com

Websites:

- Ken White's Coin Flipping
  http://shazam.econ.ubc.ca/flip/index.html
  This site allows you to see instant results for coin tossing pennies and nickels.
- Create a Graph
  http://nces.ed.gov/nceskids/graphing/
  This site allows you to construct a variety of printable graphs.

Materials:

For teacher:
- Overhead projector
- Computer connected to projection device for whole group viewing
- Overhead graph transparency or graph poster
- Overhead calculator (optional)
- Transparency of "The Big Race" game board, game markers, and overhead die

For each pair of students:
- The Big Race game board
- Penny Flipping Tally sheet
- A zip lock baggie including the following items:
  - ✓ 2 sets of 3 large cards for each student marked 0, 1, and ?
  - ✓ 12 markers such as buttons or beans
  - ✓ 2 die of different colors if possible (foam rubber die come in multiple colors and work well)
  - ✓ one penny

Teacher Preparation

Teachers should bookmark needed sites and make sure they are accessible. Download unitedstreaming video clips to desktop and preview. Make sure needed plug-ins are installed to view clips and interactive sites.
Place student materials listed above on desks for each pair of students.

Introductory Activity
Likely or not likely?

Begin with the following motivational activity to get your students thinking about probability:

1. Ask: Have you ever heard the expression "When pigs fly?" What does that mean? What about the expression, "It's like finding a needle in a haystack?"
Begin the discussion by telling the students that life is a matter of chance. Either things will *always* happen, *never* happen, or *sometimes* happen. Your job will be to help determine which one by using a set of cards.

2. Have each student remove a set of 3 large cards from their baggies labeled—"**1**, **0**, and **?"** . Instruct them to hold up the "**1**" when the answer to a question is "*always*," a "**0**" when the answer is "*never*," and a "**?**" if the answer is "*sometimes*."

3. Say, "Listen to the questions I ask and choose a card to hold up to show your response."
Ask students the following questions and wait for response cards to be held up:

- How likely is it that you will wake up tomorrow with a new extra finger on your hand?
- What is the probability that a watermelon will grow from a peach tree?
- How likely is it that the sun will rise in the morning?
- What is the probability that the principal will walk into our room today?
- How likely is it that you will graduate from high school within one week from now?
- What is the probability that it will be dark tonight?
- How likely is it that it will rain tomorrow?
- What is the probability that you will have a spelling test next week?
- What is the probability that each of us will win one million dollars in the lottery tomorrow?
- How likely is it that you will get a phone call from a friend this evening?
  Continue to make up your own questions if desired.

4. Following the activity, explain to the students that this is what probability is all about- determining the likelihood of events or happenings. Write the word *probability* on the overhead or board. If time allows, take students to the http://thesaurus.reference.com/ site and type in the word *probability*. As the synonyms are listed, note the words *chance*, *odds*, and *likelihood* are words
that mean the same thing as *probability*. Explain to students that some things will *never* happen, such as growing a new finger overnight and pigs flying, while some things *always* happen, like the sun rising each morning. However, the majority, or most, of the things that happen fall somewhere in between these two. Some things are *more likely* to happen than others just

as some have *less of a chance* of happening, like finding a needle in a haystack. Learning about probability helps us determine the chances of something happening or not happening.

Learning Activity

COIN FLIPPING ACTIVITY

1. **SAY**: "Let's look at a common example of probability most of us have probably done sometime in our lives. How many of you have ever flipped a coin? Why do you think people flip coins? What are the possible outcomes? Do you think it's fair? Why?"

2. **Provide a Focus for Media Interaction** by saying: "Watch as a coin is being flipped and be ready to make a prediction based on your observation." **Play** video segment *Understanding Probability and Odds* and **pause** when you hear "*What are the chances the next one will be heads?*" **Ask:** "How many of you think it will be heads? Tails? Do you think there's a better chance that the next toss will be heads or tails? Why?" Accept all possible predictions.

3. Provide a **Focus for Media Interaction** by saying: "Let's check our predictions and find out how statisticians explain coin flipping." (Tell students a *statistician* is someone who collects numerical data and interprets it). "Be ready to tell me what they say the chances will be and if you agree with what they say." **Resume** video and **STOP** when you hear "*the odds would still be even.*" **Ask:** "What do statisticians believe about flipping coins?" (It's always 50/50 even though you might flip heads 20 times in a row). "Have you ever heard the expression 50/50 before? What does that mean?" (You have an equal chance or a 1 in 2 chance of flipping heads or tails).

4. **Ask**: "Do you believe that even though a coin could land on heads 20 times in a row, the probability of getting heads or tails the next time is still 50/50? How can that be? Do you think coin tossing is fair? How could we prove that theory to be right or wrong?" Engage students in a discussion that the only way to prove the theory is to toss a penny many times and record the results.

5. Tell students that they will flip pennies in this activity and ask them to predict how many heads and tails they think they will get if they flip a penny twenty times. Have student pairs take a penny from their baggie and instruct them to toss the penny ten times and record each outcome on their Penny Flipping Tally Sheet using tally marks.

6. After each pair of students has recorded their data for ten tosses, ask them to share their results by making a statement about their data. Examples might be: "We flipped 3 more heads that tails," or "We flipped an equal amount of heads and tails." Ask others to listen to the results and raise their hands if they hear a statement that matches their data.

7. Ask, "What do you think the results would be if you flipped your pennies 100 times? Do you think there would be a lot more heads than tails or the other way around? How could we check our predictions? How long do you think it will take us to flip a penny 100 times? What would you say if I told you we could flip our pennies 100 times in a matter of seconds? Do you have any idea how we could do that?"

8. Go to Ken White's Coin Flipping site http://shazam.econ.ubc.ca/flip/index.html and demonstrate the coin flipping contest and recording of data using tally marks. (*At this site you will choose between flipping a Canadian penny or dime. Once you have selected the coin, type in the number of tosses you want up to 100. The site will instantly give you a visual of the number of heads and tails along with the numerical data*.)

9. Have students type in 100 flips and record their data using tally marks on their Penny Flipping Tally Sheet. After pairs have recorded their data, allow them to share their results with the class and compare results among students. Have students give true statements about their own data. Examples might be "there were 7 more heads than tails," or "there were 2 fewer tails than heads." Ask others to raise their hands when they hear a statement that is true about their own data.

10. Ask, "Is there any other way we could show this data other than using tally marks? Could we show this data on a graph?" Explain that a graph is a simple way to show data visually. Take students to the Create a Graph site and take them through a demonstration. *(At this site you begin by choosing the type of graph you want to use. You type in a title for the graph along with a title for the x-axis (horizontal), and the y-axis, (vertical). You then type in a title for Bar 1 (heads) and Bar 2 (tails) and the value for each according to the data you collected. At the bottom you can choose a minimum and maximum value for your graph. 1-75 is a good choice for this activity. You also have options for direction, size, color and style. Once you've made your selections you can choose the image file type and create a printable version of your graph.)*

11. Using the data from one of the penny tosses, guide students through a demonstration of creating a graph. As you explain the different types of graphs, ask students what type of graph would be best to use. Allow them to look at each type of graph and if necessary, explain that bar graphs are used primarily to compare data and would be the best choice. After selecting the bar graph, ask students to help provide the necessary information to be included on the graph (labels, title, scale) and the importance of each. After modeling the construction of a sample graph to be sure students include all necessary labels, have each pair of students create a graph to share their results of 100 flips as a visual way of representing their data.

12. After the graphs have been completed, have students print one graph per pair and display their results. Ask students to give true statements about their graphs and compare this data with their tally mark data. Post the graphs and allow students time to share and compare their graphs with others. **Ask**, "Are the graphs similar? If so, how?" Students should come to the conclusion that the probability of flipping heads or tails average out to be almost equal over a period of 100 or more flips regardless of whether heads is flipped twenty times in a row.

DAY 2

1. **Say**: "Yesterday we experimented with coin flipping. What have you learned about the probability of flipping coins?" (*Each time you flip a coin you have a 50/50 chance of heads or tails but if you flip a coin enough times, you will end up with about the same number of heads as tails*). "Flipping coins is an example of a high probability. That is, you have a 1 in 2 chance, or a 50/50 chance of tossing a head or tail each time you flip the coin. But not all probabilities are that high. The lottery is an example of a very low probability. The probability of winning the lottery is about 1 in 5 million… not a very good chance. Can you think of any other examples of low probabilities?" (*finding a needle in a haystack, etc.*) "The chance, or probability, of most things happening to us is usually somewhere between the two. Some probabilities are higher than others."

2. Explain to students that probabilities often change. Keeping track of data helps you make better decisions. Give a **Focus for Media Interaction**. **Say**, "Now we are going to watch a video clip about a contest that involves another example of probability. During the contest, we will need to keep track of the data." Ask for a student volunteer who will help keep a tally count of the data and draw a large T chart on the board. To Provide a ***Focus for Media Interaction*** **say**, "Listen for what kind of cookies and how many of each kind are in the container." **Begin** the video segment where you see the elf and witch with a cookie jar. **Pause** after seeing the word "probability" on the screen. **Ask:** "What is in the container?" (*25 chocolate and 25 gingersnap, 50 in all*). Instruct the

student volunteer to label one side of the T chart Chocolate and the other side Gingersnap. Write the number 25 above each label. **Say**, "To begin the contest, each may choose 4 cookies. Could you tell which kind of cookie the witch is interested in? Do you think she has a better chance of choosing a chocolate or a gingersnap?" Allow students to discuss this.

3. To Provide a ***Focus for Media Interaction*** say, "Listen to what they are trying to do as they each choose 4 cookies." **Resume** and **pause** when you hear the witch say, "Oh, who cares?" **Ask**, "What are they trying to do?" (*Choose 4 cookies of the same kind in a row*) "Do you think there's a good chance that this will happen? Why or why not?" (*Allow students time to predict. Accept all possible predictions*).

4. Provide a ***focus*** by saying "Let's watch as they each draw 4 cookies and check our predictions. As each cookie is drawn, our student recorder will need to use tally marks to keep track of our data." Instruct student recorder to use 1 tally mark each time a cookie is drawn and record it under the correct column. **Resume** and **pause** after the elf has drawn her fourth cookie and says, "chocolate". **Ask**, "Were either of them successful in drawing four of the same kind?" (*no*) "According to our tally marks, has the probability changed any? How?" (*There are now 20 chocolate cookies left in the container and 22 gingersnaps*.) **Ask**, "Are there more chocolate or gingersnap cookies in the container? So, is there a better chance of choosing chocolate or gingersnap?" (*A slightly better chance of choosing gingersnap*.)

5. **Ask,** "Do you think they will be successful if they try again? Can you predict what will happen as they continue to play more rounds?" *(Accept all possible responses).* Provide a ***focus*** by saying, "Let's watch and check our predictions as they try again. Student recorder, be sure to keep tally marks recording our data." **Resume** and **pause** when you see the numbers 4 and 3 on the screen and the witch says, "Four for pointy ears." **Ask** students: "Were either of them successful this time? How many gingersnaps does the witch have?" (*3*) "the elf?"(*4*) **Ask**: "How has the probability changed since the beginning of the contest?" (*There are now 16 chocolate and 18 gingersnaps in the container*.) "Is there a better chance of drawing chocolate or gingersnap?" (*gingersnap*) "How do you know?" (*Allow students to study the data on the T chart and freeze frame and give their ideas and explanation. There is still a slightly better chance of choosing a gingersnap*).

6. **Focus** students by **saying**, "Now the witch wants to make the contest more interesting. Listen for the challenge the witch proposes and what she hopes to win." **Resume** and **pause** when you hear the magician say "Ready." **Ask:** "What is the witch's challenge?" (*to draw any four of the same kind*). **Ask**, "What does she win if she is successful?" (*all of her favorite cookies*). "What happens if she isn't successful?" (*She loses*

everything) "How many think she has made a wise choice? The elf thinks she has a better chance of choosing a combination of cookies. Do you agree with her? Why or why not? Who would take the chance and risk losing everything?" *(Allow students to predict who will win the contest.)*

7.Provide a **Focus** by saying, "Who's ready to find out how the contest ends up? Let's watch to see if the witch has a successful outcome." **Resume** and **stop** when the elf takes a bite of the chocolate cookie and says "Not bad." **Ask:** "Was the witch successful? Who won the contest?" (*the elf*) "Why do you think it was so hard for the witch to draw four of a kind in a row? Do you think that was a high or low probability?" (*low*) "Would it be as likely as tossing a penny? Would it be as unlikely as winning the lottery?" (*Students should come to the conclusion that it is possible to draw four of the same kind but unlikely because there were about the same number of each cookie in the container.)*

Culminating Activity: The Big Race

Say: "You have learned that probabilities can be high, having a better chance of something happening like flipping a coin, or low, being unlikely to happen, like winning the lottery. You have also learned that knowing certain information or data can help you determine whether your chances are higher or lower."

Say, "Let's use what we've learned about probability to play a game and experiment with the probabilities of rolling dice. Pretend that you are at a NASCAR race. How many of you have ever been to a race before? Do you have a favorite driver? Do you think race car drivers win because of chance or because of their skill?" Follow with a discussion that it involves skill and luck. "Today we are going to use probability to help us predict which racecar will win the race. This activity is called 'The Big Race'."

The Big Race

In this activity, students play, "The Big Race," in which twelve cars compete to cross the finish line first. The cars are numbered 1-12. Two dice are used. A particular car will move one space towards the finish line when the sum of the two dice rolled equals its number. Students make predictions about which car they think will finish first. Students will play the game many times to generate data.

1. Each pair of students should have a copy of "The Big Race" game board. The teacher should use a game board transparency and overhead die to model the rules of the game. Make a class bar graph on large graph paper. (Graph posters may be purchased at teacher supply stores). Label one axis

1-12 for each of the cars. Label the other axis "Number of Races Won". Title the graph, "The Big Race".

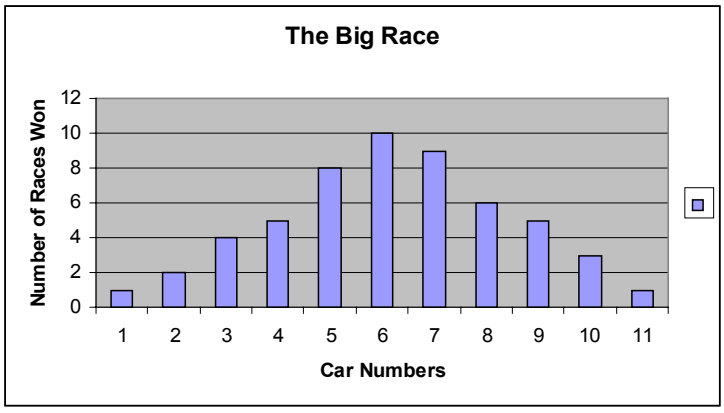
2. Place a copy of the game board transparency (see attachment) on the overhead and place 12 buttons or similar markers on the starting line, one to represent each car. Roll 2 overhead die and explain the car whose number matches the sum of the die moves ahead one space. Continue to roll the die and move a car until one car has made it to the finish line. The results of the race will be the car who won.

3. Allow students to cheer for different cars during the demonstration race and predict which car will finish first. During the overhead demonstration, pause frequently to look at the results. Ask students if they notice a pattern in the way the cars are moving. Ask students to comment on why they think some of the cars haven't moved yet. Ask: "Do you think this is a fair race?"(*Students may suggest it isn't fair since they were assigned a particular car, especially if they chose Car 1 as it's impossible to roll a 1 with two die.*) Students may want to change their predictions as the race progresses. It is okay to change predictions as they receive new information.

4. After the completion of the demonstration race, record the winning car by filling in one square on a large bar graph grid, to represent that car's victory. (See sample graph below)

5. Instruct students to play as many rounds of the game with their partners as time allows. Have students record each race result on the class graph as soon as a game is completed. Emphasize the importance of recording data accurately, as statisticians do. After students have had sufficient time to play several games, the graph should begin to show that cars 6-8 have more wins than the other cars, if data is accurately recorded. The more games played, the better the results will be.

Sample graph:



6. Discuss the results of the class graph as soon as each pair has had the opportunity to play the game and record their results at least twice. Ask

questions such as, "Who won the most races? How many more races did car 6 win than car 3?" etc. To check comprehension ask students to give reasons why some cars won more often than others.

7. **Say**, "Let's look at another way of showing the same thing we just saw. Each group has a set of die (each of a different color if possible). On the overhead projector make a number line from 1- 12. Above each number have students generate the different combinations you could throw with the two die to get that particular number. Allow them to use their die to make different combinations. For example, 5+1 or 1+5 would be written above the 6. There would be no combination above the 1 since there is no way to throw a 1 using 2 die. Continue until the chart is complete."

8. When the chart is complete it will form a bell curve and show the average being in the range of 6, 7, and 8. **Ask**: "Which is more likely to happen, rolling a combination of 7 or rolling a combination of 4? Can you explain your answer?"(*There are more ways of rolling a 6, 7, or 8*) "Which roll is impossible using two dice?"(1)

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					5+1	4+3	6+2				
				4+1	1+5	2+5	2+6	6+3			
			1+3	1+4	2+4	5+2	3+5	3+6	6+4		
		2+1	3+1	2+3	4+2	6+1	5+3	5+4	4+6	6+5	
	1+1	1+2	2+2	3+2	3+3	1+6	4+4	4+5	5+5	5+6	6+6
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**

Assessment:

Have students write an explanation for the results of "The Big Race". Additional assessment could be a paper/pencil activity with questions, which involves predicting outcomes by answering with *always, never,* and *sometimes*. Students will also be given a picture graph and/or a bar graph to interpret. The assessment can be modified to meet the needs of students at higher-grade levels.

Cross Curricular Extensions:

Math/Science

- Have students collect and record data from other probability activities. Using graph paper or graphing software, graph the results of the data collected and record the probabilities of each occurring.

- Investigate how biologists use probability to determine the survival of species from a sampling.

- Investigate the use of probability in forecasting the weather. How do forecasters predict the path of a hurricane?

- Take a survey in your class as to how many are in favor of the lottery and those that aren't. Record your results on a graph. Predict outcomes of an extended survey within the school and graph results. Take a third survey asking adults only. Graph data and compare all three graphs. Discuss the results and reasons given for the pro-con of the lottery.

Art

- Have students illustrate pictures of different probabilities. Some pictures will show events that happen always, never, or sometimes. Have other students determine the chance of these happening and categorize the pictures into the three different categories.

- Post the pictures on the wall in the three categories. (It would be helpful for the students to write a sentence describing the event in their picture.)

- Study a variety of game boards and design one of your own.

Social Studies

- Study and play the game of the dreidle and determine the probability using the game.

- Study games from other cultures that use probability.

- Investigate the use of probability and the economy, stock market, and politics.

Physical Education

- Determine the probability of local sports teams winning a championship etc.

- Use scores of physical fitness test results from previous years and determine the probability of students winning a race or competition in a particular field event.

- Write a report on the difference of games involving skill and those involving chance. What makes games fair? How are the Olympics different from other games?

Language Arts

- Have students read a story beginning, predict and write an ending according to the variables in the story.

- Design a game complete with directions, rules, and a spinner or other type of probability device. Be sure to make the game fair.

- Conduct a debate on the effectiveness of the lottery and the pros and cons of it. Why do some states have the lottery and others don't?

Computer

- Have students use a graphing program or Microsoft Excel for Windows to graph results of particular probability extension activities.

- Have students experiment with spinners as they customize their own to adjust probabilities and collect data at the following site:
  Probability
  http://www.shodor.org/interactivate/activities/prob/index.html
  This site allows you to customize spinners and dice to adjust probabilities and spin or roll to collect data in tally mark form.

- Have students look up terms like probability, statisticians, probably, chance, etc. at the following website:
  Thesaurus.com
  http://shazam.econ.ubc.ca/flip/index.html

Community Connections:

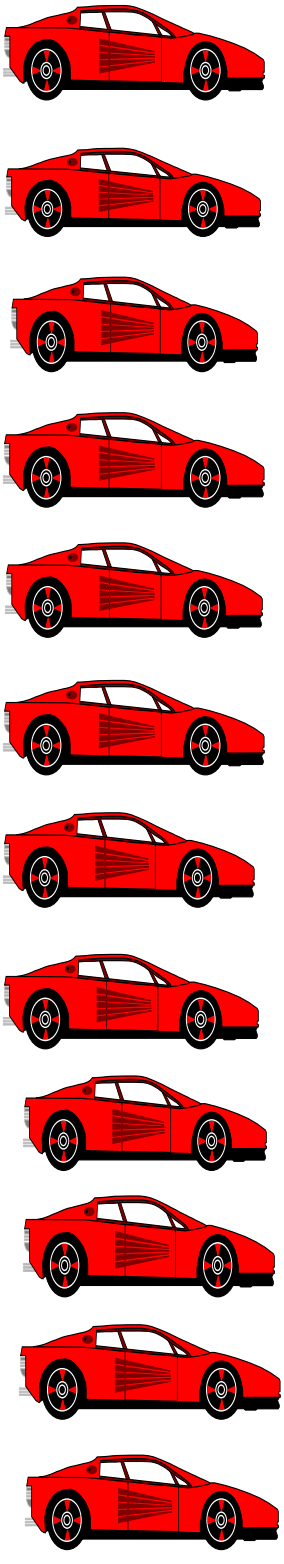
This is an opportune time to have someone like a meteorologist to come in to talk to the class about how s/he uses probability in determining weather forecasts.

If possible, take a field trip to the local television station to talk with a meteorologist to see the technology used to gather and report weather data.

Invite a local government official to talk to the class about the lottery and how the profit is used to help the state.

How do game makers use probability in designing games for manufacturing? Investigate the art of making games. What makes some games more popular than others?

The Big Race



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Penny Flipping Tally