



## Topic: Fair Games

Grade: Seventh

An integrated lesson plan covering 7 sessions of approximately 1 hour each.



### Lesson-Planning Approach

Some learners perceive their “world” as a whole, where all things are interconnected and dependent upon each other. These “integrated” students face major challenges in coping with our dominant educational, social, and economic systems, which tend to present information in a linear fashion without the necessity of integration into meaningful context. Integrated students are at-risk of failing as they attempt to grasp information in ways that do not match their experience. Among large populations of at-risk students are many from Native American and similar cultures who do not regard their world as a sum of parts but as a blend of all that they experience.

This lesson plan does include some traditional, linear approaches to delivering information (checklists, rules, analysis, problem solving and organization). In addition to the traditional, linear delivery of information, this lesson plan also includes some of the following strategies, designed to appeal to at-risk students as they learn academic/life skills:

- ❖ Integration of technology
- ❖ Story telling/anecdotal information
- ❖ Non-competitive group and team work
- ❖ Performance-based assessment and rubrics
- ❖ Visual presentations and practice through technology and other means
- ❖ Project-based assignments that integrate family and community
- ❖ Activities appealing to multiple intelligences (Gardner)

### Lesson Overview

In this lesson students will experiment with coins and dice to find probability. They will then discover what happens when they simulate the experiment on an Excel spreadsheet where they will be able to do up to 1000 tosses or more in a few seconds. They will demonstrate fair games by creating a fair game and write a description of the game.

## Lesson Objectives

**Project Objectives: When students complete this session, they will be able to...**

Produce a game that is fair.

Perform experiments to determine experimental probability.

Demonstrate the equivalence of probabilities as a common fraction, decimal, and percent

Determine the theoretical probability.

Simulate experiments on a computer.

Determine the expected value.

Analyze games of chance to determine if they are fair or not.

**Integration of Other Functional/Academic Skills:** (Critical thinking is required throughout the lesson.) Students will be able to...

Writing: Explain in writing how to determine the experimental and theoretical probability.

Technology: Use the computer to simulate an experiment.

## Standards

**Colorado State Standard Three:** Students use data collection and analysis, statistics, and probability in problem-solving situations and communicate the reasoning and processes used in solving these problems.

3.5 Determining probabilities through experiments or experiments.

3.6 Making predictions and comparing results using both experimental and theoretical probability drawn from real-world problems.

**NCTM Standard:** Understand and apply basic concepts of probability.

## Websites

**Required:** none

**Support:**

[www.mathgoodies.com](http://www.mathgoodies.com) I did not use this site in the lesson, but it is a very good site and has a lot of activities on probability.

[www.tkcs-collins.com/truman/monopoly/monopoly.shtml](http://www.tkcs-collins.com/truman/monopoly/monopoly.shtml) This is a good site. It is over the head of middle school students, but it has probabilities for playing the game monopoly.

## Pre-requisites

Students will need a basic understanding of probability and how to write probability of an event

## Required Materials

Dice  
Coins

The book Use the Spreadsheet as a Tool in the Secondary School Mathematics Classroom by William J. Masalski. This book is available from NCTM. It has the Excel programs that will simulate several probability experiments. It also has many other secondary programs for math. It comes with a book and a computer disk.

## Required Equipment/Technology

Computers  
Excel spreadsheet

## THE LESSON

**Note:** Students do not learn from what you do but from what you have them do.

### Preparation

#### Day One

Activity	Instructor Notes
Discuss the game of monopoly. Look at the board. What are the best properties to buy? Explain how the game is based on probability.	Give some of the information given on website <a href="http://www.tkcs-collins.com/truman/monopoly/monopoly.shtml">www.tkcs-collins.com/truman/monopoly/monopoly.shtml</a> . This site gives the probability of landing on all the squares on the board. He also explains how he got the probabilities by simulating over a billion plays.

### Presentation

#### Days One, Two

With a partner do an experiment using a coin. Flip it fifty times. Record how many heads or tails you get on Handout One. Combine the class totals and record the results on Handout One.	
Use the Technology Checklist to learn how to use the spreadsheet	<b>I used a spreadsheet file that I got from the book "Use the Spreadsheet as a Tool in the Secondary</b>

Name

3

file. Using the computer simulate the experiment flipping the coin 100 times, 500 times, and 1500 times. Fill in the tables on Handout Two as you finish the simulations. Answer the questions on the bottom of Handout Two.	<b>School Mathematics Classroom” by William J. Masalski for the simulations. It is available through NCTM.</b>
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### Performance and Practice Days Three, Four

Instructions for students	Teacher notes
With a partner do an experiment using two dice. This time you must add the numbers on the two dice each time you toss them. Make tables similar to the ones on Handout One to record the results for this experiment.	<b>The students need to make a list of all possible outcomes for this experiment to find the theoretical probabilities for each sum. Students have trouble understanding that there are 36 outcomes rather than 12.</b>
Using the computer simulate the experiment tossing the dice 100 times, 500 times, and 1500 times. Make tables similar to the ones on Handout Two to record the results for this simulation.	

### Presentation Day Five

Is the game rock, scissors, paper a fair game? Discuss what makes a fair game.	<b>The probability of winning is the same for rocks, paper, or scissors. For each it is 2 out of 9. (There’s a 3 out of 9 probability of tying.) A fair game is when all players have the same chance of winning (the expected value is equal).</b>
Is this game fair? Toss two dice. Add the numbers. If the numbers add to an even number, Player A gets 3 points. If the numbers add to an odd number, Player B gets 3 points. Discuss why it is fair or not.	<b>There are 36 total sums possible. Of the 36, 18 are even and 18 are odd. Since A and B get the same number of points, the game is fair. Show how to find the expected value by multiplying the probability by the points. If the expected value for each player is the same, the game is fair. In the discussion ask how the game could be made to favor one player or the other.</b>

### Performance and Practice Days Six, Seven

Instructions for students	Teacher notes
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Name

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<p>Using what you know about probability and fair games, create a game that would be fair to all the players. Be creative in designing your game. Write a description of your game. Explain how it is played and show your expected value work.</p>	
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## Lesson Assessment Strategy (Formative – As the lesson progresses)

### Preparation, Presentation and Overall Implementation (Instructor)

1. Are the instructions and expectations for the class clear from the beginning?
2. Am I spending sufficient time on modeling the skills I want students to acquire?
3. Is there enough variety in the lesson to appeal to most learning preferences?
4. How many learning intelligences am I addressing?
5. Are students “connecting” to lesson objectives? How?
6. How is this lesson “integrated?”

### Performance and Practice (Student)

1. Do all students have the skills to follow instructions? If not, what measures am I taking to address the challenge?
2. Are all students participating in the activities either by active observation or by voicing their thoughts?
3. Am I identifying the strengths of each student and pairing/grouping people accordingly? What results am I getting?
4. How are students performing? Are all of them able meeting 80% of the lesson objectives? If not, what am I doing to help them achieve more?

### Technology

1. Is the technology working?
2. How are students reacting to the technology.
3. How are students applying or wanting to apply their technical skills in other areas?
4. What do I need to remember when I teach this lesson again?

## Activity Checklist

	Discuss the game of monopoly. Look at the board. What are the best properties to buy? Explain how the game is based on probability.
	With a partner do an experiment using a coin. Flip it fifty times. Record how many of each number you get on Handout One. Combine the class totals and record the results on Handout One.
	Using the computer simulate the experiment flipping the coin 100 times, 500 times, and 1500 times. Fill in the tables on Handout Two as you finish the simulations. Answer the questions on the bottom of Handout Two.
	With a partner do an experiment using two dice. This time you must add the numbers on the two dice each time you toss them. Make tables similar to the ones on Handout One to record the results for this experiment.
	Using the computer simulate the experiment tossing the dice 100 times, 500 times, and 1500 times. Make tables similar to the ones on Handout Two to record the results for this simulation.
	Is the game rock, scissors, paper a fair game? Discuss what makes a fair game.
	Is this game fair? Toss two dice. Add the numbers. If the numbers add to an even number, Player A gets 3 points. If the numbers add to an odd number, Player B gets 3 points. Discuss why it is fair or not.
	Using what you know about probability and fair games, create a game that would be fair to all the players. Be creative in designing your game.

## Technology Checklist

	Open the Excel folder.
	Double click on Coin Toss Excel
	Enter a 1 in C3.
	Press Enter. Notice that in C7 it records what you tossed-heads or tails. Notice that in C9 it records one toss. In C11 through C17 it records how many heads and how many tails you have thrown and what the percentage of the total tosses each has.
	Move the box back up to C3. Press F9 function key. Notice that all the columns change based on what you tossed.
	Continue pressing F9 function key. Notice what happens.
	Hold down the F9 function key. Notice what happens. Try to end on exactly 50 tosses. Practice trying to land on an exact number of tosses.

## Handouts

### Flipping a Coin Experiment-Handout One

Side of Coin		Tallies of Times Thrown		Number of Times Thrown	
Heads					
Side of Coin	Total	Experimental Probability Fraction	Experimental Probability Decimal	Experimental Probability Percent	Theoretical Probability
Heads					
Tails					

### Computer Totals - Handout Two

Side of Coin	Total out of 100	Experimental Probability Fraction	Experimental Probability Decimal	Experimental Probability Percent
Heads				
Tails				

Side of Coin	Total out of 500	Experimental Probability Fraction	Experimental Probability Decimal	Experimental Probability Percent
Heads				
Tails				

Side of Coin	Total out of 1500	Experimental Probability Fraction	Experimental Probability Decimal	Experimental Probability Percent
Heads				
Tails				

How many times do you have to flip the coin to make probability match the theoretical probability?

Points	Game	Written Description
5	<ul style="list-style-type: none"> <li><input type="checkbox"/> The game is creative.</li> <li><input type="checkbox"/> The playing directions are clear and complete.</li> <li><input type="checkbox"/> The probabilities and points are different for each player.</li> <li><input type="checkbox"/> The game is fair.</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> You explain the game clearly.</li> <li><input type="checkbox"/> You include the directions, the probabilities, the points, and the expected value.</li> <li><input type="checkbox"/> You use correct punctuation, grammar, spelling, and sentence structure.</li> </ul>
4	<ul style="list-style-type: none"> <li><input type="checkbox"/> The playing directions are clear and complete.</li> <li><input type="checkbox"/> The probabilities and points are different for each player.</li> <li><input type="checkbox"/> The game is fair.</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> You explain the game.</li> <li><input type="checkbox"/> You include the directions, the probabilities, the points, and the expected value.</li> <li><input type="checkbox"/> You use correct punctuation, grammar, spelling, and sentence structure in most of your paper.</li> </ul>
3	<ul style="list-style-type: none"> <li><input type="checkbox"/> The playing directions are complete.</li> <li><input type="checkbox"/> The probabilities and points are the same for each player.</li> <li><input type="checkbox"/> The game is fair.</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> You explain the game.</li> <li><input type="checkbox"/> You include the directions, the probabilities, and the points.</li> <li><input type="checkbox"/> You use correct punctuation, grammar, spelling, and sentence structure in some of your paper.</li> </ul>
2	<ul style="list-style-type: none"> <li><input type="checkbox"/> The playing directions are not complete.</li> <li><input type="checkbox"/> The probabilities and the points are the same for each player.</li> <li><input type="checkbox"/> The game is fair.</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> You explain the game, but it is not clear.</li> <li><input type="checkbox"/> You include the directions and the points.</li> <li><input type="checkbox"/> You have many mistakes in punctuation, grammar, spelling, and sentence structure in your paper.</li> </ul>
1	<ul style="list-style-type: none"> <li><input type="checkbox"/> The playing directions are not complete.</li> <li><input type="checkbox"/> The probabilities are different, but the points are the same for each player.</li> <li><input type="checkbox"/> The game is not fair.</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> You explain the game, but it is not clear.</li> <li><input type="checkbox"/> You include the directions and the points.</li> <li><input type="checkbox"/> You use very little correct punctuation, grammar, spelling, and sentence structure in your paper.</li> </ul>