Title: Are You Game? A Lesson Connecting Fractions and Probability

Link to Outcomes:

- **Problem Solving** Students will solve problems in mathematics including problems with practical application to the real world and problems which are solved in a cooperative atmosphere.
- **Communication** Students will communicate mathematically. They will read, write, and discuss mathematics.
- **Reasoning** Students will reason mathematically to make inferences, gather evidence, and build arguments.
- **Connections** Students will connect the topic of probability with fractions and apply it to the real application of games of chance.
- **Estimation & Computation** Students will apply estimation strategies to determine fractional parts of a circle.
- **Number Sense & Operations** Students will apply fractional concepts using concrete and abstract materials.
- **Statistics** Students will collect, organize, and display data and will interpret information obtained from these displays. Students will write their findings based on statistical information.
- **Probability** Students will demonstrate the basis concepts of probability including predicting and analyzing the concept of "fairness."
- **Mathematics Disposition** Students will demonstrate a positive and practical attitude toward the role of mathematics in school, culture, and society.

Brief Overview:

This activity integrates probability with fractions and applies it to analyzing games of chance. Students will examine various commercially produced games for fairness. They will analyze, given spinners, to determine fairness. Students will design a spinner and then create a game which effectively utilizes their spinner.

Grade/Level:

Grade 5 & 6

Duration/Length:

This activity takes approximately 3 to 5 days. Duration depends on the instructional level of the learners and modifications made by the instructor.

Prerequisite Knowledge:

Students should have a basic understanding of the following:

- naming and shading fractional regions
- equivalent fractions
- basic probability concepts

Objectives:

- Students will identify characteristics of games of chance.
- Students will analyze games and spinners for fairness.
- Students will make predictions about the fairness of given spinners.
- Students will conduct a test for fairness and collect and record data.
- Students will write an interpretation of the collected data.
- Students will be able to estimate given fractional regions of a circle.
- Students will be able to shade fractional regions of a spinner.
- Students will report verbally and in writing the results of problem solving.
- Students will create a game of chance with a spinner.

Materials/Resources/Printed Materials:

- One Post-It note per student
- Chart paper or blackboard with empty Venn diagram
- Assortment of commercial board or card games of chance (Candyland, Chutes & Ladders, Hi Ho Cherry-O, Slap Jack, Go Fish, War, MAD Magazine Game, etc.)
- Chart paper
- Large paper clip - 1 per group
- Student Resource 1 - 1 per student
- Teacher Resource 2 - Large poster or transparency
- Student Resource 3 - 1 per student
- Student Resource 4 - 1 per group
- Student Resource 5 - 1 per group
- Teacher Resource 6 - Chart or transparency
- Teacher Resource 7 - Instructions to make fraction plate
- One fraction plate per student
- Student Resource 8 - 1 per student
- Student Resource 9 - 1 per student
- Teacher Resource 10 - Class Anecdotal Record

Development/Procedures:

Day 1

- Students will be looking at commercially produced games. The concepts of "chance" and "fairness" will be the focus.

- Prepare for today's lesson by constructing a large Venn diagram on the blackboard. Do not label the areas of the diagram. Leave space to the side of the Venn, and label the space Our Favorite Games.

- Ask students to think of a well known board game or card game that they enjoy playing. As the students are thinking, pass out one Post-It note to each child. Ask students to record their favorite games on the Post-It note, and place it on the board in a designated area beside the Venn diagram labelled Our Favorite Games.

- Tell the students that you are going to place the Post-It notes in one of two sides of the Venn. Their job is to discover the label for each side of the Venn (Concept Attainment). Teachers should then move some of the notes, games of chance to one area of the Venn and games that involve strategy to the other area. As students begin to discover the labels for the areas, they may raise their hands (to signal they have an idea) but NOT call out the answer. After suitable wait-time, discuss what the labels could be and why. Allow the students to continue placing any remaining notes into the appropriate areas of the Venn. **Extension:** You may want to discuss games that might fit into both categories.

- Explain to the students that today they will be playing some games of chance. Tell the students that, as they play the games, they should be thinking about what makes this a game of chance. Allow sufficient time for students to play the games.

- Return materials and gather as a group. Elicit from students possible definitions as to what is a game of chance. Read the following out loud:

  > A game designed to give all participants an equal chance of winning. Ask the students if they are comfortable with this definition and make adjustments as needed. Be sure everyone is operating with the same definition.

- On chart paper, record student responses to the following question:

  > What characteristics did your game have that made it a game of chance? Display this chart in the room throughout the unit.

- Pass out the homework Games at Home (Student Resource #1). Explain that students should evaluate some games at home and fill in the Venn diagram.

Day 2

- Students will evaluate and test spinners for fairness. They will collect data and interpret results.

- Ask students to find a partner and share their homework from the previous day. Then ask students to share an example with the class.

- Using a transparency or chart of the spinner posters (Teacher Resource #2), ask students to predict which spinner may be fair and which spinner may be unfair when used in a game of chance. Elicit from students the reasons why the spinners would be fair or unfair. Elicit from the students that the fair spinner is divided into equal parts so each player has an equal probability of landing on any of the areas of the spinner; whereas, the unfair spinner is divided into unequal parts, and the probability of each player landing on each of the areas of the spinner is unequal.

- Pass out the four spinner worksheet (Student Resource #3). On a transparency of the spinners, show one at a time and ask students to label on the worksheet whether the spinner is fair or unfair. Collect worksheets, and explain that the students will use the worksheets again the next day. Ask the students to start thinking of games or scenarios using spinners.

- Pass out one spinner game mat (Student Resource #4), one paper clip, and one data collection tool (Student Resource #5) to each group. Ask the students to predict which of the spinners would be a fair spinner and which would be an unfair spinner. Ask students to write their predictions in their journals. Explain to the students that they are going to test to see if their predictions are correct.

- Tell the students that they are to use a paper clip and a pencil as the spinner. Remind them that for a fair test, one should have the same person spin in the same manner. They are to spin 20 times on each spinner and record tally marks on the data collection tool. Model a few examples. Allow sufficient time to complete the activity.

- Gather the students together, and record class results on the transparency or chart (Teacher Resource #6). Discuss the results with the class. Does the data support their predictions? Discuss why or why not.
  Extension: Look at the theoretical probabilities of the spinner, and compare them to the experimental probabilities as evidenced by the data.

- Journal - Ask the students to write an explanation of what makes a spinner unfair in a game of chance.

Day 3

- Students will estimate fractional regions and apply concepts of fairness to an individual assessment. The culminating activity may be started.

- Pass out the four spinner worksheet from the previous day. Ask the students to work in groups to brainstorm possible games or scenarios where the spinner might be used. Share the students' ideas with the class.

- Pass out the fraction plates (instructions on Teacher Resource #7). Ask the students to model various fractions such as 1/5, 2/3, etc. Elicit from the students some of their strategies as to how they estimate fractional parts.

- Collect the fraction plates from the students and pass out the individual assessment (Student Resource #8) to each student. Explain the directions to the students, and allow enough time for the activity to be completed.

Culminating Activity - This activity may be started on Day 3, if time allows.

- Pass out the **Make Your Own!** Activity Sheet (Student Resource #9). Explain to the students that they are employees of a toy manufacturer, they have been given the job of designing a unique spinner, and they are designing a game to go with the spinner. The students may work individually, in pairs, or in groups. Review the directions with the students and allow them time to create, test, revise, and share their games. The duration and depth of this activity is entirely at teacher discretion.

Evaluation:

Students will be assessed on the following:

- **Group Work** The class anecdotal record (Teacher Resource #10) is a useful tool. Students will be assessed by on-task behaviors and individual problem solving, and participation in the group setting.

- **Journal Response** The response should be clear and use language and vocabulary related to the topic. It should reflect clearly the student's understanding of the mathematical concepts involved.

- **Individual Assessment** The students will be assessed on mathematical correctness and ability to apply the concepts to a real-life situation.

- **Culminating Activity** The teacher will assess students on quality of their writing, mathematical accuracy, and response to task.

Extension/Follow Up:

- The spinner in the culminating activity may be constructed by using fractional parts to figure interior angles. See the appendix or refer to *Arithmetic Teacher*, February, 1993, pages 352-358.

- The computer program Take A Chance by MECC is an excellent technological extension for this lesson.

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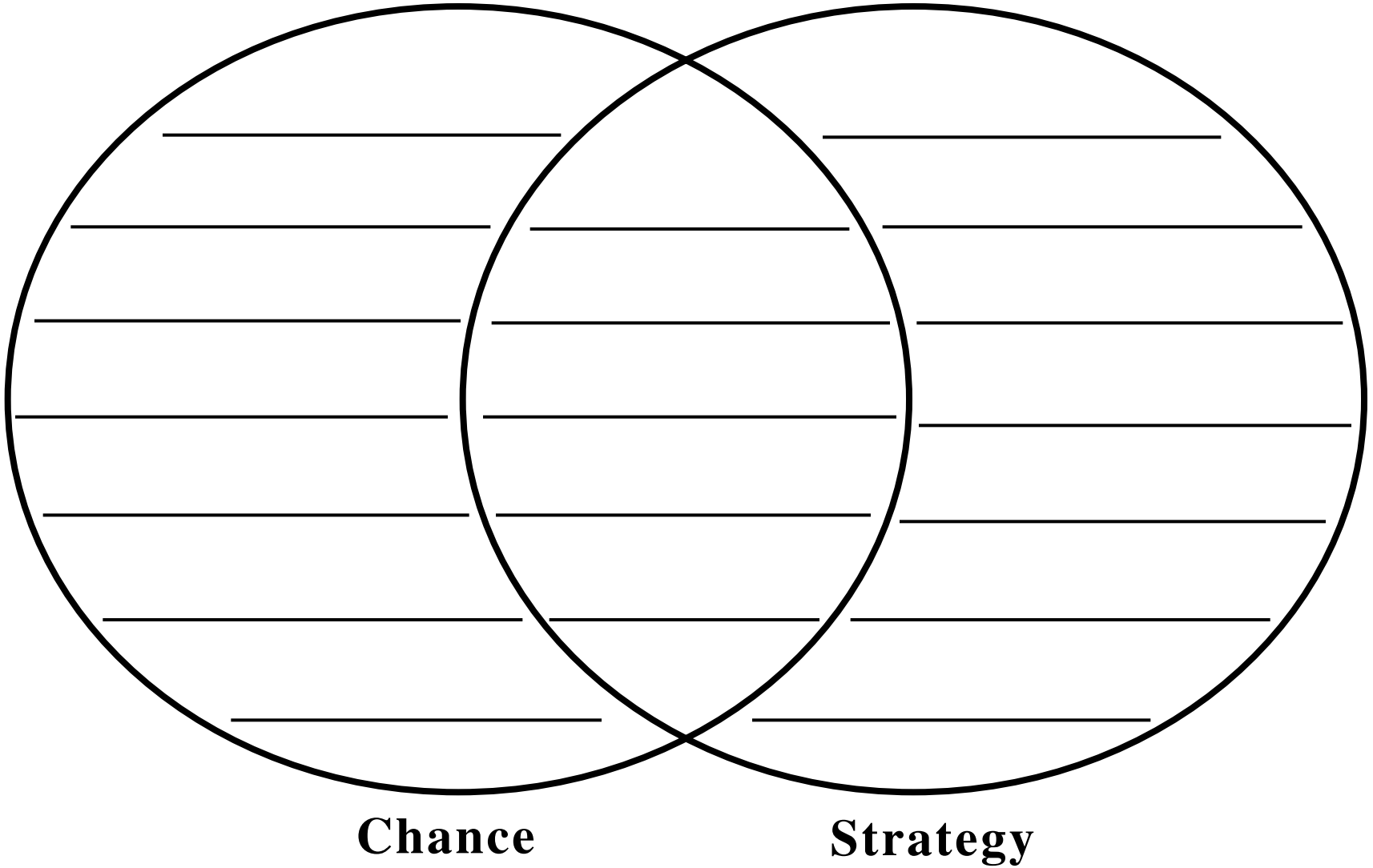
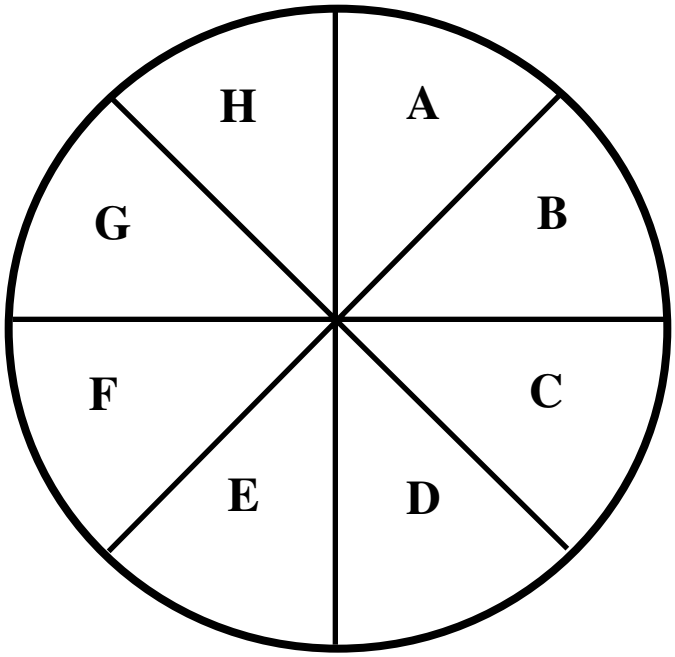
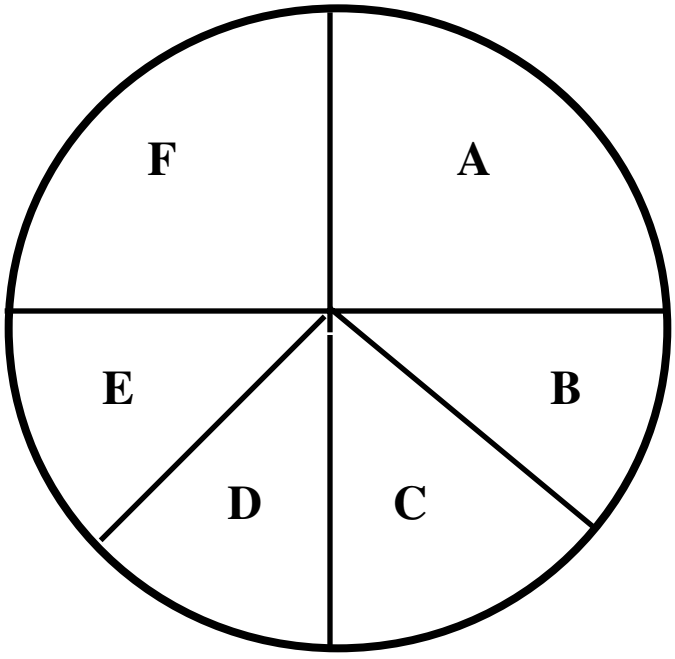
GAMES AT HOME



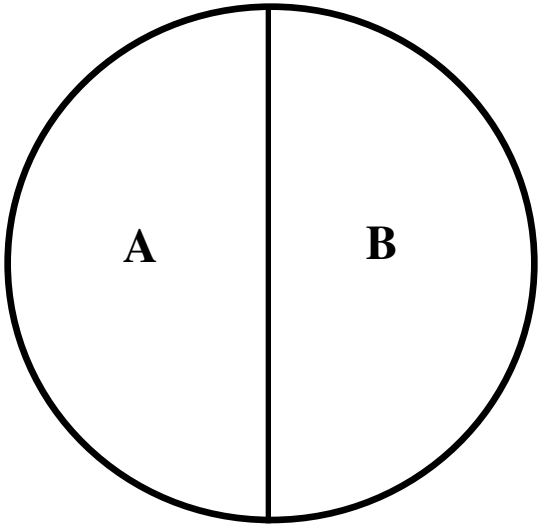
SPINNER POSTER
Fair or Unfair?



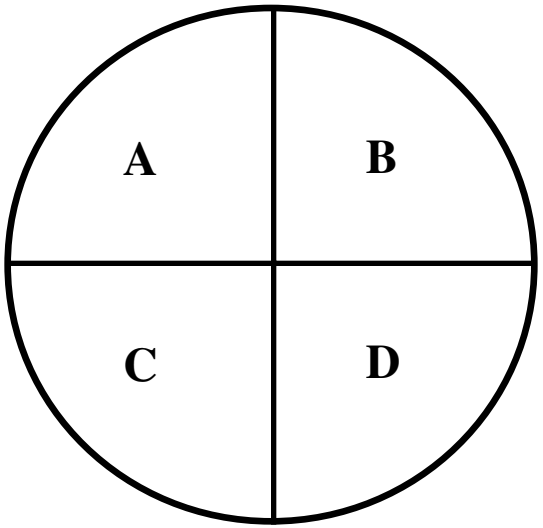


FOUR SPINNER ACTIVITY SHEET

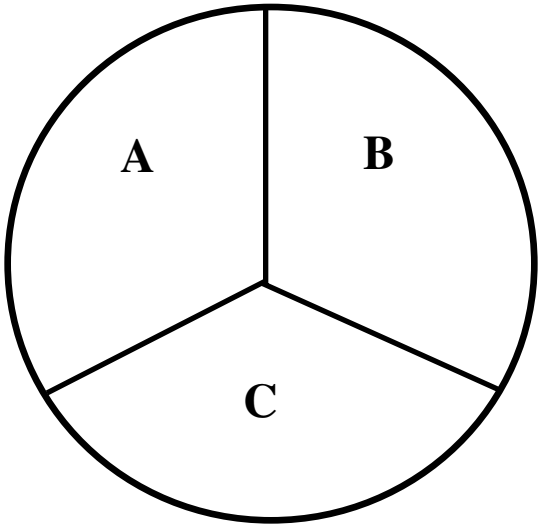
Spinner I



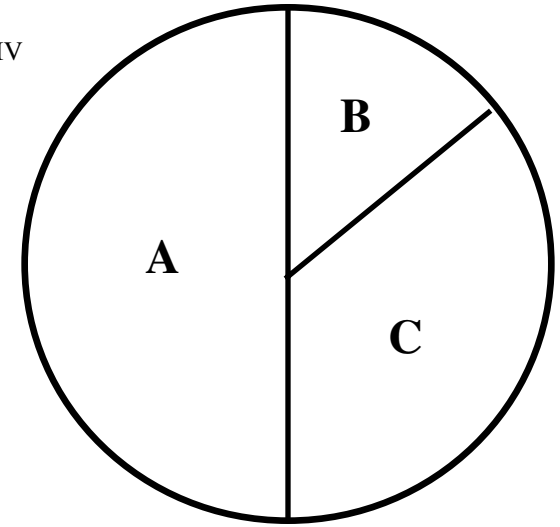
Spinner II



Spinner III



Spinner IV

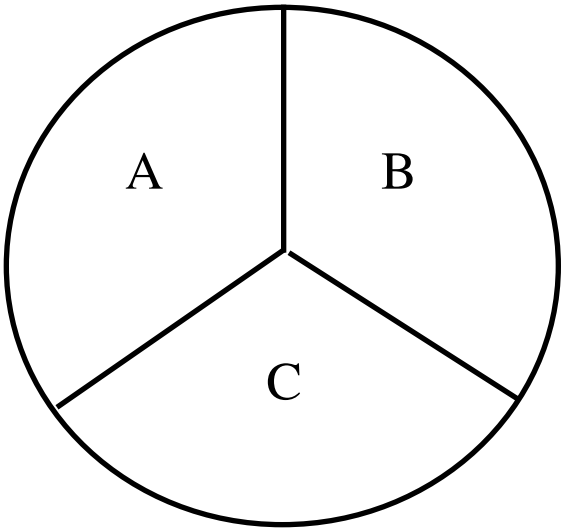


Spinner Game Mat

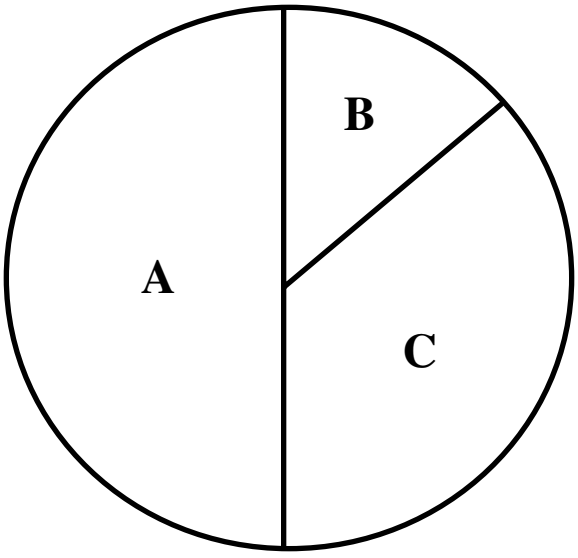
Directions

1. Use a pencil and a paper clip to make a spinner. Make sure the pencil is in the middle of the circle for each spin.
2. Spin each spinner 30 times. After each spin, record on the data collection sheet at which letter the spinner is pointing. Be sure to keep an accurate count as you go.
3. Calculate the totals and be ready to share with the class.

1.



2.



Name _____

Date _____

Data Collection

(Group record)

Use spinners one and two. Spin each spinner 30 times, and tally the results in the appropriate column A, B, or C. Tabulate the totals for each column for both spinners one and two. Report your results to your teacher.

Spinner 1	A	B	C
Predictions			
Tally			
Total			

Spinner 2	A	B	C
Predictions			
Tally			
Total			

Class	A	B	C
Spinner 1			
Spinner 2			

DATA COLLECTION - CLASS RECORD

Spinner 1	A	B	C
GROUP 1			
GROUP 2			
GROUP 3			
GROUP 4			
GROUP 5			
GROUP 6			
GROUP 7			
TOTAL			

Spinner 2	A	B	C
GROUP 1			
GROUP 2			
GROUP 3			
GROUP 4			
GROUP 5			
GROUP 6			
GROUP 7			
TOTAL			

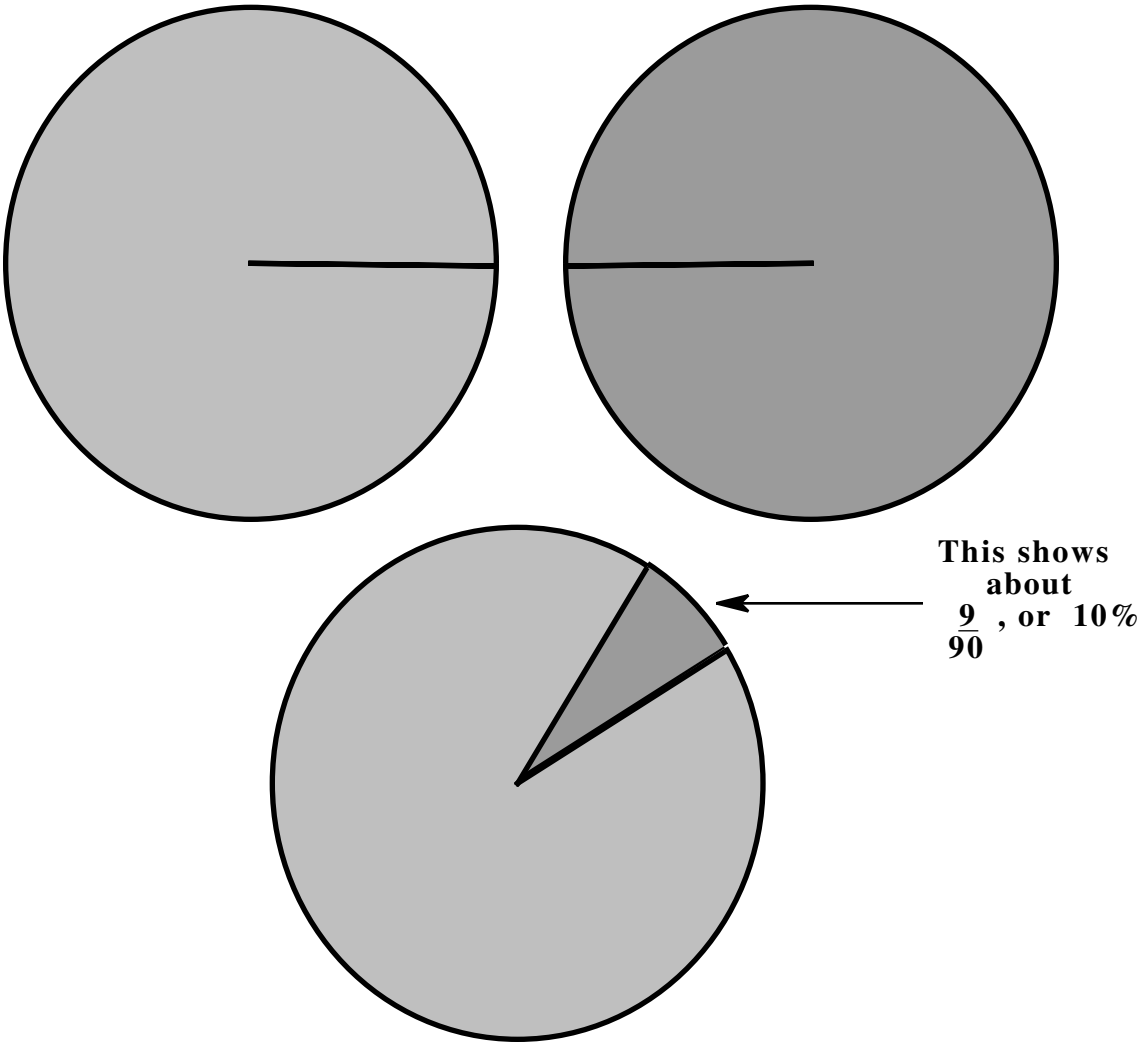
Fraction Plate

Directions

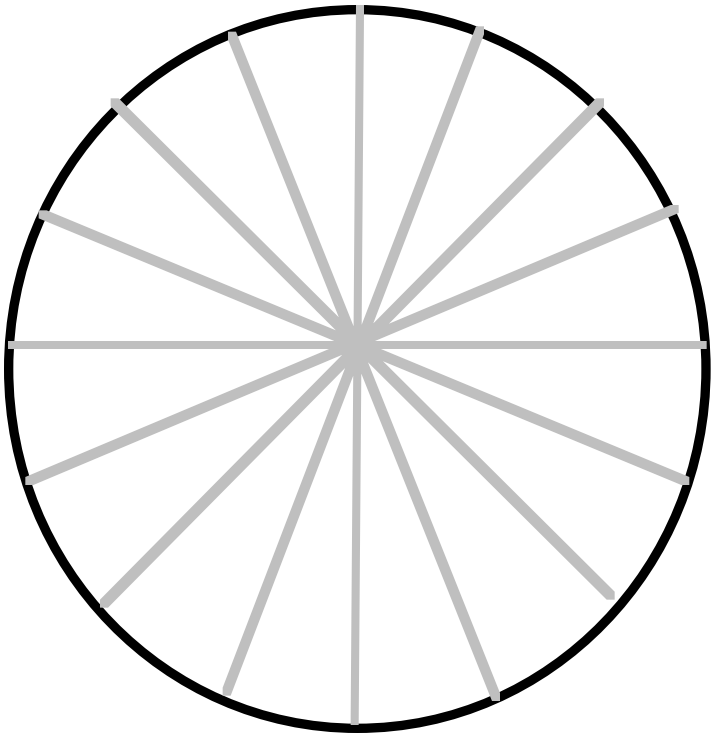
EPR (**E**very **P**upil **R**esponse)

1. Obtain two paper or plastic plates that are two different colors.
2. Cut each plate from one edge to the center (a radius cut).
3. Place the two plates so that the cuts meet.
4. Slide so that the two plates overlap.
5. Now you have one two-layered plate that will show two colors.

Suggestion: This can be done with more than two plates.



Spinner Assessment Activity I



1. Color @ of the spinner RED.
2. Color # of the spinner BLUE.
3. Color ^ of the spinner GREEN.

Is this a **FAIR** spinner? Why or why not?

_____

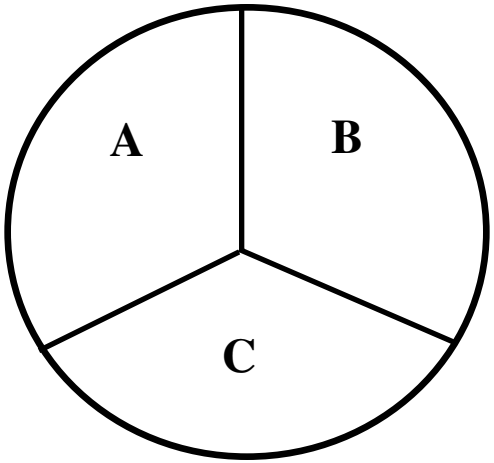
_____

_____

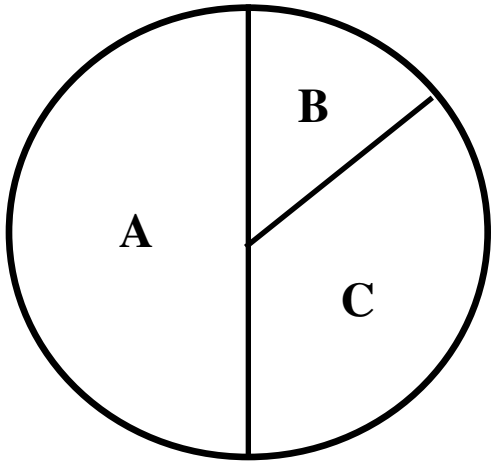
_____

_____

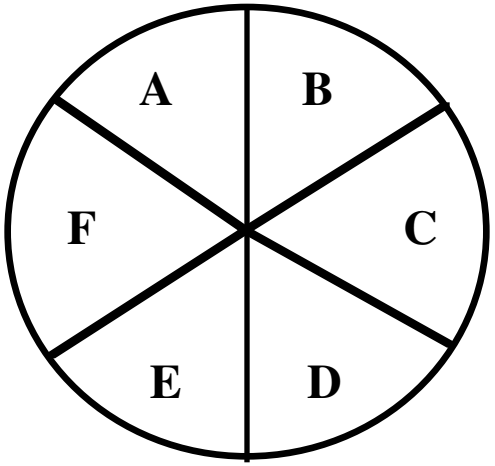
SPINNER ASSESSMENT ACTIVITY II



SCENARIO



SCENARIO



SCENARIO

I. **Thomas went to the mall with his mother. At the center of the mall, there was a mini-carnival to make money for the local preschool. One activity was a lollipop tree. In order to get a lollipop, you spun a wheel, and the color you landed on determined whether you would get a red, green, orange, purple, pink, or yellow lollipop. Thomas hoped he'd get an orange!**

II.

Kyle's summer is a time of difficult choices. On the 4th of July weekend, Kyle is faced with three equally exciting choices of what to do. His Boy Scout troop is going on a rafting trip. His sister won tickets to a Hootie & the Blowfish concert and agreed to take a friend and him. His friend, Robert, invited him to go to a Virginia lakehouse. Kyle is overwhelmed and decides to leave his fate to chance. He uses a

III. **spinner to decide how he will celebrate the 4th!**

Kathy was excited that her trip to Ocean City included an evening on the boardwalk. At the arcade there was a booth where spinning a wheel wins a prize. Some people

MAKE YOUR OWN!

MEMORANDUM

To:
From: Company President
Re: New Toy Development

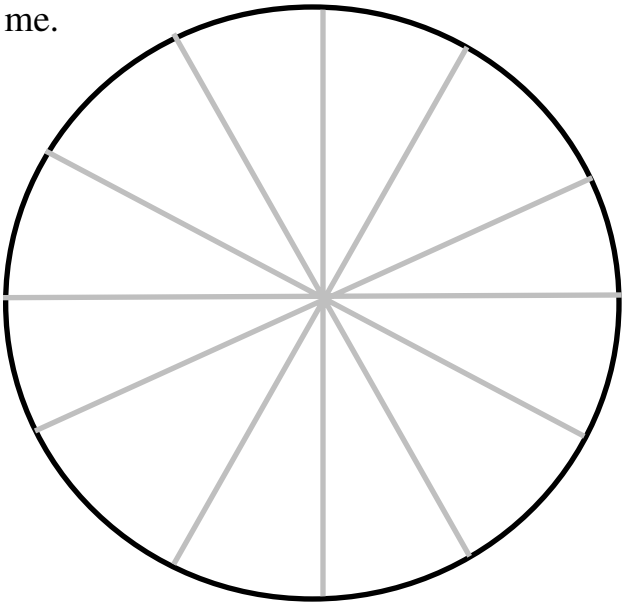
We need a new game! It has come to my attention that our competition will be releasing a new game within the week, and to offset any damage, we must be ready to release our own game as soon as possible. The game must include a spinner. Follow the steps below and have the finished product on my desk ASAP!

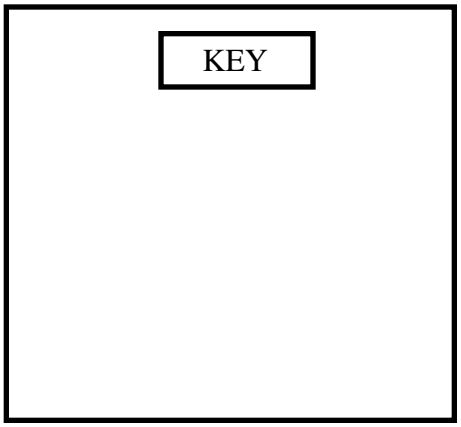
1. Create a spinner in the circle below by shading at least four fractional regions. Use a different color for each region. The box next to the circle is the key. In the box, label the regions as fractional parts in simplest form.

2. On a separate piece of looseleaf paper, write a complete sentence describing whether this is a fair spinner or an unfair spinner. Explain why.

3. Design a game that utilizes your new spinner. Be sure to write the rules for the game on your piece of looseleaf.

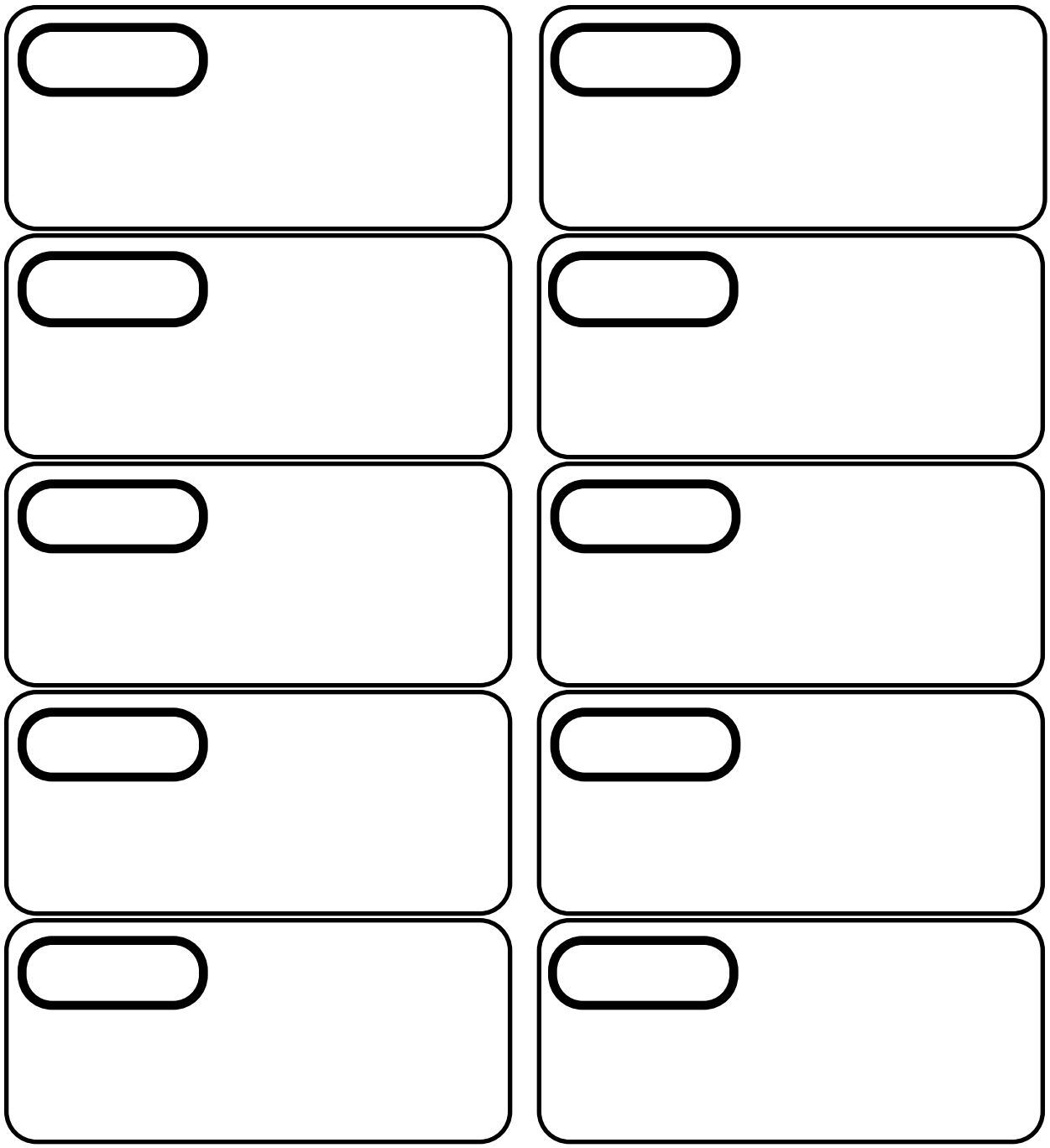
4. Be sure to field test the game and make any revisions BEFORE you give it to me.





ANECDOTAL RECORD

Subject _____ **Lesson** _____



Appendix

TABLE 1

Mathematics-related board and card games

Game name	Place	Price	NCTM Standard (Grades 5–8)												
			1	2	3	4	5	6	7	8	9	10	11	12	13
Aggravation	S	$ 9.86	X	X	X	X				X	X		X		
Backgammon	S	$ 12.99	X	X	X					X	X		X		
Battleship	S	$ 11.99	X	X	X	X				X	X		X	X	X
Checkers	S	$ 2.87	X	X	X					X			X		
Chess	S	$ 3.99	X	X	X					X			X		
Chess Teacher	S	$ 12.99	X	X	X					X			X		
Chinese Checkers	S	$ 2.99	X	X	X					X					
Clue	S	$ 9.99	X	X	X	X							X		
Concentration	S	$ 12.99	X	X	X					X				X	
Connect 4	S	$ 9.99	X	X	X					X				X	
Deck of Cards	S	$ .99	X	X	X	X	X	X	X	X	X	X	X	X	
Dominoes	S	$ 3.58	X	X	X					X					
Life	S	$ 11.99	X	X	X	X	X		X	X			X		
Magnet (checkers, chess, and backgammon)	S	$ 6.99	X	X	X					X			X		
Master Mind	S	$ 8.99	X	X	X					X					
Match 4	S	$ 3.49	X	X	X					X			X	X	
Monopoly	S	$ 9.99	X	X	X	X			X				X		
Othello	S	$ 12.99	X	X	X					X					
Parcheesi	S	$ 9.99	X	X	X						X				
Pente	S	$ 14.99	X	X	X						X			X	
Perfection	S	$ 15.99	X		X					X				X	
Risk	S	$ 17.87	X	X	X	X				X					X
Rummikub	S	$ 9.99	X	X	X			X		X		X	X		
Simon	S	$ 29.97	X	X	X					X					
Skipbo	S	$ 6.79	X	X	X				X	X			X		
Snapshot	S	$ 19.95	X	X	X					X				X	
Sorry	S	$ 12.87	X	X	X				X		X				
Spirograph	S	$ 8.96	X		X					X				X	X
Stratego	S	$ 9.99	X	X	X	X				X			X		
Teasers	S	$ 9.99	X		X					X					
Tic Tac Toe	S	$ 2.99	X	X	X					X					
Tic Tac Turn	S	$ 9.98	X	X	X					X					
Triominoes	S	$ 6.96	X	X	X					X					
Triple Yahtzee	S	$ 7.97	X	X	X	X		X	X	X	X	X	X		
Uno	S	$ 4.49	X	X	X					X					
Yahtzee	S	$ 4.95	X	X	X	X		X	X	X	X	X	X		
Travel size:															
Battleship	S	$ 6.97	X	X	X	X				X	X		X		X

TABLE 1—Continued

Mathematics-related board and card games

Game name	Place	Price	NCTM Standard (Grades 5–8)												
			1	2	3	4	5	6	7	8	9	10	11	12	13
Connect 4	S	$ 6.47	X	X	X					X				X	
Drive Ya Nuts	S	$ 5.99	X	X	X					X					
Simon	S	$ 22.99	X	X	X	X				X					
Yahtzee	S	$ 2.99	X	X	X	X		X	X	X	X	X	X		
Division III															
Contig 60	P	$ 9.00	X	X	X			X	X	X	X		X	X	
FAB	P	$ 9.00	X	X	X		X	X	X	X	X		X		X
Juggle	P	$ 8.00	X	X	X	X				X			X	X	X
Queens and Guards	P	$ 6.00	X	X	X					X				X	
Stars & Bars	P	$ 13.00	X	X	X	X			X	X				X	
Division IV															
Frac Fact	P	$ 12.00	X	X	X		X	X	X	X	X		X		X
Fraction Pinball	P	$ 5.00	X	X	X	X	X	X	X	X			X	X	
Pent 'Em In	P	$ 11.00	X	X	X	X				X			X	X	X
Prime Gold	P	$ 10.00	X	X	X			X	X	X	X		X		
Remainder Islands	P	$ 10.00	X	X	X	X			X	X	X		X	X	
Multicultural Mathematics Materials include:	N	$ 6.00													
Dreidel	N		X	X	X	X			X	X			X		
Five field ko-no	N		X	X	X	X				X					
Konane	N		X	X	X	X				X					
Ko-no	N		X	X	X	X				X					
Lu lu	N		X	X	X	X			X	X					
Nine men's morris	N		X	X	X	X				X					
Patolli	N		X	X	X	X			X	X	X		X		
Senet	N		X	X	X	X			X	X					
Tangrams	N		X	X	X	X	X	X	X	X				X	X
Tapatan	N		X	X	X	X				X				X	
Totolopsi	N		X	X	X	X				X	X		X		
Wari	N		X	X	X	X			X	X	X				
Multicultural Posters and Activities include:	N	$ 9.00													
Nine men's morris	N		X	X	X	X				X					
Oware	N		X	X	X	X			X	X					
Soma cubes	N		X	X	X	X				X				X	X
Tangrams	N		X	X	X	X	X	X	X	X				X	X
Tower of Brahma	N		X	X	X	X		X		X	X				X

Note: S = store bought
P = Pentathlon Institute
N = NCTM

Ya Gotta Play to Win: A Probability and Statistics Unit for the Middle Grades

By **Francis (Skip) Fennell**

Probability and statistics are part of our daily lives in an ever increasing number of ways. State lotteries, casino gambling, and sports at all levels continue to fascinate millions of people.

With the number of people who invest time, energy, and—more importantly—money in activities involving probability, it is time that we use this social phenomenon to relate probability, statistics, and particularly gaming to the curriculum in grades 5–8. This article discusses such a unit.

Unit preplanning

Before beginning the study of probability, ask the pupils to bring in some of their favorite games of chance. Explain that a game of chance contains dice, a wheel, a spinner, cards, or other devices to decide moves, chances, and so on. Some examples of the more popular games are Monopoly, Chutes and Ladders, old maid, Yahtzee, Kismet, Cootie, Pay Day, and Gambler.

Purchase several pairs of dice, decks of cards, spinners, polyhedra dice, and other probability materials for unit instruction and follow-up activities. If applicable, display state lottery materials and information.

Inform parents of the probability and statistics activities. Although social applications involving probability and statistics are to be encouraged, care must be taken in presenting a unit on gaming. A letter or an evening session describing the intent of instruction involving gaming, along with an opportunity to discuss the activities, should be given to all parents. Although gambling is presented here as a social and practical application of probability and statistics, students are cautioned about the actual odds against their likelihood of winning. In fact, by understanding how probability and statistics can be applied to gaming, students are likely to see the statistical hazards involved in any gambling activity.

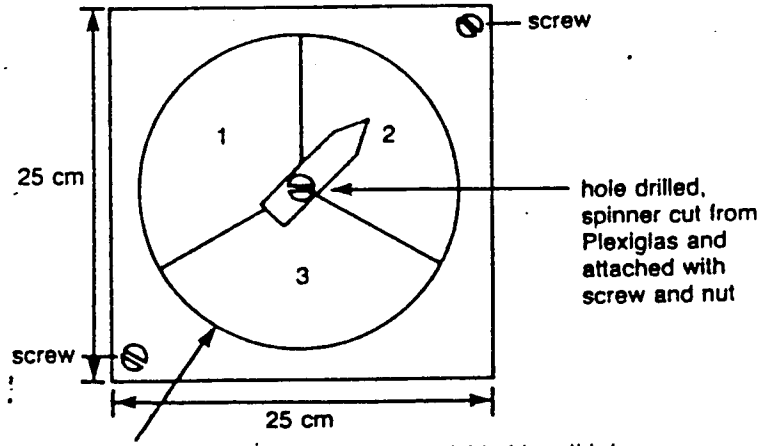
Day one

Construct an overhead Plexiglas transparency spinner similar to that shown in figure 1. Use two 25 cm × 25 cm pieces of Plexiglas. A hole can be drilled through the middle of the two pieces and a spinner attached with a screw and nut. Interchangeable colored transparency circles divided into thirds, fourths, sixths, and so on, can be inserted between the Plexiglas pieces.

Using the Plexiglas and the transparency circles divided into thirds discuss the outcomes of the spinner. Ask the students how many possible outcomes there are on the spinning wheel. The probability of an event can be described as the numerical way to express what the chance is that an event will occur. The probability of an event is most frequently written as proper fraction. For example,

$$\text{probability of an event} = \frac{\text{the number of ways the event can occur (successes)}}{\text{total number of events (outcomes)}}$$

Fig. 1 Construct an overhead spinner transparency.



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So the probability that the spinner will land on 2 is 1/3. The transparency divided into fourths can now be used with the Plexiglas overhead spinner to reinforce the definition of the probability of an event. In addition, use a coin to provide an additional example of using chance. What is the probability of flipping a head? A tail? (1/2)

The next step in reinforcing the concept is to provide an example of tallying or recording. Try flicking the spinner sixty times and having the class record the results. A similar tally can be made with fifty tosses of a coin. Some charts for recording the results are shown in figure 2.

The tallying experiment will approximate closely the equally likely outcomes of these events if a large number of tallies is recorded. An optional activity is to use a spinner transparency divided into four unequal sections (see fig. 3). Ask the students to predict results and discuss the fairness of this wheel.

Days two and three

Provide a regular die for each small group of pupils. Have the pupils determine the probability of rolling each number. Use the die to assist in defining odds. The odds against an event may be defined as the ratio of the number of unfavorable events to the

Fig. 2 Sample charts for recording experiments with a spinner and a coin

Spinner Tally

Record the number where the spinner stops

1 2 3 4

Coin Flipping Tally

Record a head or a tail

Heads Tails

Fig. 3 Not all numbers are equally likely to be chosen.

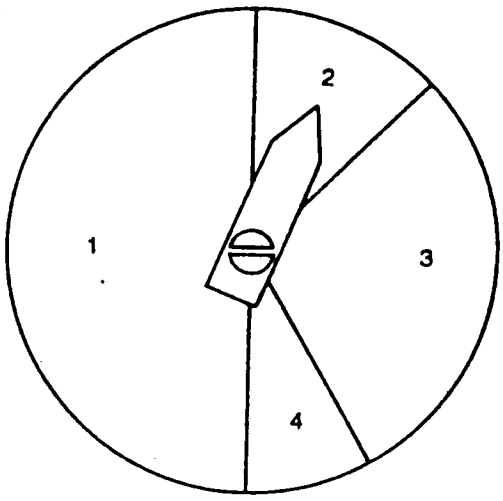
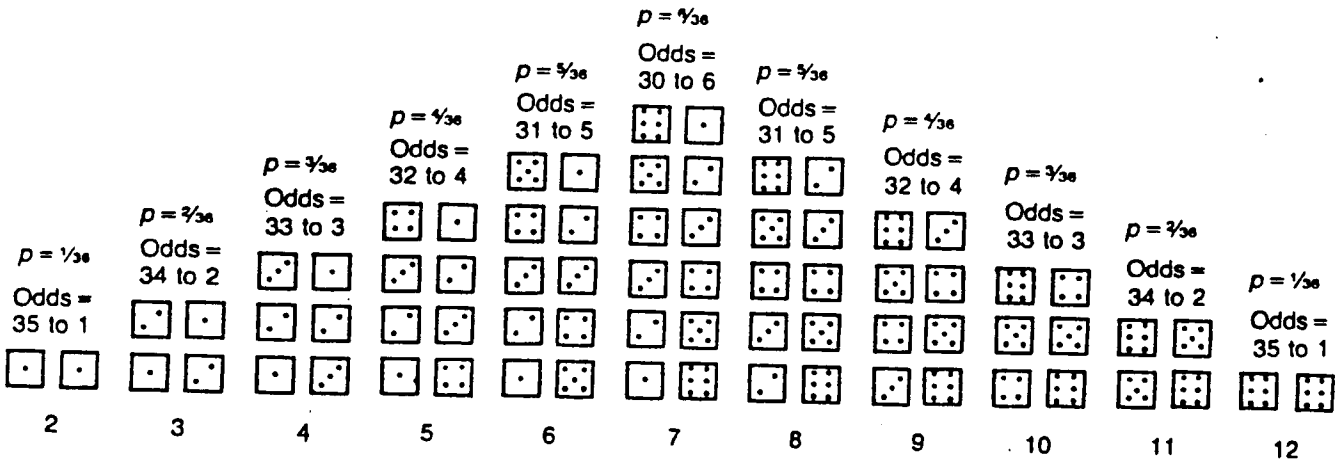


Fig. 4 Probabilities and odds in the toss of two dice



number of favorable events.

For example, when a die is rolled, the odds are 5 to 1, or 5:1, against someone rolling a 1 because only one of the die's six sides is a 1 and the other five sides are not:

odds against an event occurring

$$= \left(\begin{matrix}\text{number of} \\ \text{unfavorable events}\end{matrix}\right) : \left(\begin{matrix}\text{number of} \\ \text{favorable events}\end{matrix}\right)$$

Next, make sure that each student has a pair of dice. Encourage the students to roll the dice and define the probability and odds of all events involving two dice. Students should then construct a chart similar to that in figure 4, illustrating the probable occurrences of each roll. The outcomes in figures 5 and 6 present the sums and products using two dice.

The probabilities of sums and products provide an opportunity to analyze basic addition and multiplication fact combinations. Which sum(s) or product(s) is/are most likely to occur? Least likely? How can we use the probability of rolling sums and products to help us in learning facts or in winning games? Have the pupils roll and record sums according to the chart in figure 7. Using a tally or frequency count aids pupils in determining the total sum of all fifty rolls and the average, or mean, roll of the fifty rolls. Pupils can also find the most frequent sum and can arrange the dice sums in bar or line-graph format similar to the sample graph provided in figure 7.

Pupils may find it interesting to repeat the dice activity by rolling and recording fifty products. The product distribution, the average, and the most frequent product will provide an interesting comparison to the sums recorded in figure 7.

Day four

Provide standard decks of playing cards for each of several small groups in your classroom. Have the pupils determine the probability and odds of the following:

Fig. 5 All possible sums in the toss of two dice

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

1. Drawing a face card

   The probability is 12 of 52, since 12 of the 52 cards are face cards. This fraction can be restated in its lowest terms as 3/13, consistent with the fact that there are 3 face cards for each suit of 13 cards. The odds against drawing a face card are 40 to 12, expressed in its simplest form as 10 to 3. Thus, in each suit of 13 cards, 10 will not be and 3 will be face cards. Teachers interested in having probabilities and odds expressed in lowest terms, have to assume a knowledge of fractions or provide instruction.

2. Drawing a red card

   The probability is 26/52, or 1/2, since 26 of the 52 cards are either hearts or diamonds. The odds against drawing a red card are 26 to 26, or 1 to 1. Therefore, the odds are even; it is just as likely that one would draw a red as a black card. Can the pupils think of other situations where there are even odds? (What about flipping a coin?)

3. Drawing a 3

   The probability is 4/52, or 1/13. The odds against drawing a 3 are 48 to 4, or 12 to 1.

4. Drawing a 4 of spades

   The probability is 1/52; the odds against this are 51 to 1.

5. Drawing a diamond

   The probability is 13/52, or 1/4. The odds against drawing a diamond are 39 to 13. The same results would hold even if the question dealt with clubs, hearts, or spades.

Provide additional examples using cards. These activities would be an excellent extension of previously learned fraction concepts.

Days five and six

Following the introductory activities of the first four days, the two-sequence described below prese probability in a gaming format.

1. Construct a carnival wheel similar to that shown in figure 8. The wheel can be constructed of triple thickness cardboard or plywood.
2. Ask your pupils what the probability is of the wheel stopping on a given number?
3. Distribute five $1 bills in play money to each pupil; then play the following carnival simulation. The "carny" leader can dress accordingly in a straw hat, striped shirt, sunglasses, and arm garters. Each pupil is to wager $1 on a num for each of five spins of the ca val wheel. Students may change their wagers for each spin of the

Fig. 6 All possible products in the toss of two dice

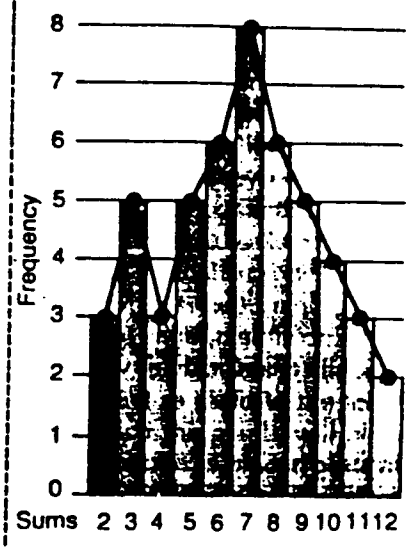
X	1	2	3	4	5	6
1	1	2	3	4	5	6
2	2	4	6	8	10	12
3	3	6	9	12	15	18
4	4	8	12	16	20	24
5	5	10	15	20	25	30
6	6	12	18	24	30	36

Fig. 7 Sums of two dice in 50 tosses

Sum	Tally or frequency	Total (sum times tally)
2	|||	6
3	𝍸	15
4	|||	12
5	𝍸	25
6	𝍸 |	36
(7)	𝍸 |||	56
8	𝍸 |	48
9	𝍸	45
10	||||	40
11	|||	33
12	||	24
	TOTAL SUM	340

1. Average or mean sum = $\frac{\text{total sum}}{\text{50 rolls}} = \frac{340}{50} = 6.8$
2. Circle the most frequent sum

(Sample) line and bar graph presenting results of 50 dice sums



wheel. Winners of each round receive their $1 wager back plus $1 more, for a total of $2.

4. Keep a running account for each spin of the wheel. Run the introductory game for five spins of the wheel. An example of an introductory game for a class of thirty students is shown in table 1.

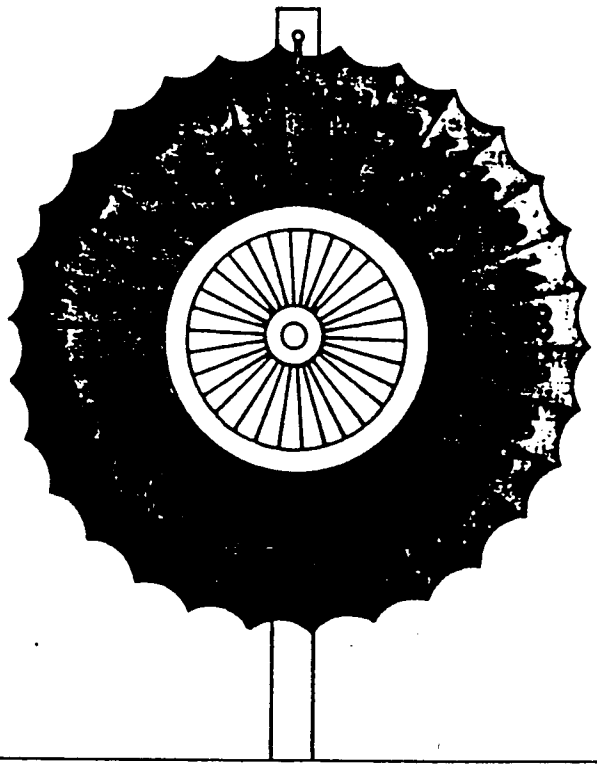
Table 1
An Introductory Game for 30 Students

Spin	Winning no.	Winners	Losers	Carnival collected	Carnival paid
1	27	2	28	$28	$2
2	13	2	28	$28	$2
3	12	1	29	$29	$1
4	11	1	29	$29	$1
5	4	1	29	$29	$1
				$143	$7

Find out how many pupils actually won money at the end of the five spins. Discuss the excitement of gaming. Describe the social problems of people hooked on gambling. Introduce materials related to horse racing and casino gambling as applications of probability. Would the results change if $10 bets were permitted?

5. Use the overhead transparency spinner shown in figure 1 and replicate part of this lesson. Have the pupils identify probability and odds and keep track of individual winnings and the carnival's totals.

Fig 8. A carnival wheel of fortune



Day seven

Pass out decks of cards to small groups of pupils. Introduce the game of blackjack, or twenty-one. Number cards are worth their designated number in this common game. Face cards are worth ten points and aces are worth either 1 or 11 points, at the

player's discretion. Each player receives his or her first card face down from the dealer. The second card is dealt face up. The object of the game is to get as close to 21 points as possible without exceeding 21. To get additional cards, a player requests a "hit," an additional card placed face up. A sum over 21 immediately disqualifies the player. Encourage pupils to keep track of their winning rounds and to use probability and odds as they compare the other cards to their own. Encourage pupils to be aware of probability and odd's when playing games out of class as well.

Day eight

Sporting events provide many opportunities for a variety of applications oriented toward probability and statistics. The following baseball card game is an activity that incorporates both probability and statistics. This game could be demonstrated first to the whole class, but it is more appropriately played in small groups.

1. Have pupils bring in their favorite baseball cards. Organize two teams of major-league players according to pupil interests.
2. Have pupils on the visiting and home teams position their cards in a simulated playing field and begin play.
3. The fielding player rolls one die, and the batting player rolls the other. The following sums indicate moves:

   2 = home run
   3 = double play
   4 = double
   5 = single
   6 = out
   7 = out
   8 = single
   9 = wild pitch
   10 = stolen base
   11 = sacrifice fly
   12 = triple

4. Pupils may use individual baseball player statistics on baseball cards to aid them in figuring out the sum needed for their play. If the baseball player on a card has a batting average of .280 or above for the season, the die is rolled two times and the player plays the better of the two rolls. The designated hitter rule would apply for this activity, since the batting average for pitchers is not recorded on baseball cards. You can revise the strategy by allowing players hitting above .280 to take a chance on a second or even a third roll of the dice, but then they *must* play their "chance" roll. Pupils should refer back to the probability of each outcome of the dice so that they can plan a game strategy.
5. As a continuation of this baseball activity, pupils may calculate the following baseball statistics:

$$\text{batting average} = \frac{\text{hits}}{\text{times at bat}}$$

$$\text{fielding average} = \frac{\text{errors}}{\text{fielding chances}}$$

$$\text{earned-run average} = \frac{\text{earned runs}}{\text{games pitched}}$$

Player comparisons and discussions of the previous season's averages for each ball player as reported on the baseball cards can provide an interesting extension of this activity.

Additional activities involving other sports can include the probability and statistical aspects of golf, horse racing, football, basketball, and track.

Day nine (optional)

If applicable, bring in and discuss information regarding statewide lottery programs. Ask pupils questions about the probability of winning, the odds, and go on. Examine lottery literature and schedule a visit by a lottery representative.

Table 2

Game Review

Title	Element of Chance	Use of Statistics	Probability, Odds used
Yahtzee	dice	recording scores	Combinations of 4 dice used. The probability of getting Yahtzee is 1/1296. Other sums and combinations occur more frequently.

Day ten

This unit contains many applications for reinforcing probability concepts and involves the games that the pupils brought in at the beginning of the unit as a culminating unit activity. Games should be reviewed according to the format shown in table 2. Remember, ya gotta play to win!

Conclusion

Teaching probability and statistics is important because of the popularity of the various applications of these subjects in our daily lives. The activities suggested in this article are only several among many that could be chosen. Many interesting and thought-provoking problems could be used. These subjects are a rich source on which we can draw in our efforts to implement *An Agenda for Action* (1980).

Bibliography

Dubisch, Roy. *Basic Concepts of Mathematics for Elementary Teachers*, pp. 381–97. Reading, Mass: Addison-Wesley Publishing Co., 1977.

Heddens, James W. *Today's Mathematics*, pp. 536–51. 93d ed. Chicago: Science Research Associates, 1974.

National Council of Teachers of Mathematics. *An Agenda for Action: Recommendations for School Mathematics for the 1980s*. Reston, Va.: The Council, 1980.

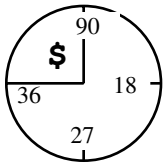
Wykes, Alan. *The Complete Illustrated C to Gambling*. New York: Doubleday & 1964.

Fractions To A Degree

Name

_____

Make and use the Wheel of Degrees on the next page to figure the number of degrees in a fraction for a complete revolution (360 degrees).



90° is the number of degrees in the central angle of the circle.

$\frac{1}{2}$ of 360° is _____

$\frac{1}{5}$ of360° is _____

$\frac{1}{8}$ of 360° is _____

$\frac{5}{12}$ of 360° is _____

$\frac{2}{3}$ of 360° is _____

$\frac{1}{12}$ of 360° is _____

$\frac{1}{6}$ of 360° is _____

$\frac{3}{4}$ of360° is _____

$\frac{1}{10}$ of 360° is _____

$\frac{1}{3}$ of360° is _____

Wheel of Degrees
Instructions

1. Cut out the two circles.
2. Cut along the thick line in each circle from the outside to the center. DO NOT cut all the way through the circle.
3. Hold the blank circle in your left hand and the other one in your right hand. Slide the two circles together so that the centers meet.
4. Move the blank wheel around to show the number of degrees.