



Math Objectives

- Students will compare experimental probability with theoretical probability.
- Students will determine the probability of given events using an area model.

Vocabulary

- experimental probability
- theoretical probability
- equally likely
- random event

About the Lesson

- This lesson involves using proportionality and a basic understanding of probability to make and test conjectures about the results of experiments and simulations.
- As a result, students will:
 - Use spinners, area models, and a basketball simulation to predict the results of real world events.



TI-Nspire™ Navigator™

- Use Quick Poll to assess students' understanding of probability and to aggregate students' experimental data.
- Use Class Capture to examine students' experimental data.
- Use Live Presenter to demonstrate and discuss the results of group and class simulations.

Activity Materials

Compatible TI Technologies :  TI-Nspire™ CX Handhelds,
 TI-Nspire™ Apps for iPad®,  TI-Nspire™ Software



Tech Tips:

- This activity includes screen captures from the TI-Nspire CX handheld. It is also appropriate for use with the TI-Nspire family of products including TI-Nspire software and TI-Nspire Apps. Slight variations to these directions may be required if using other technologies besides the handheld.
- Watch for additional Tech Tips throughout the activity for the specific technology you are using.
- Access free tutorials at <http://education.ti.com/calculators/pd/US/Online-Learning/Tutorials>

Lesson Files:

Student Activity
 One_and_One_Equals_Win_Student.pdf
 One_and_One_Equals_Win_Student.doc
TI-Nspire document
 One_And_One_Equals_Win.tns



Discussion Points and Possible Answers

Let's review probability before answering the question on Page 1.1.

1. What is experimental probability?

Answer: Experimental probability is the number of favorable outcomes divided by the number of trials.

$$P(\text{Making Shot}) = \frac{\text{Number of Favorable Outcomes}}{\text{Number of Trials}}$$

2. Give an example of experimental probability.

Sample Answer: Tossing a fair coin 100 times and getting 42 heads and 58 tails is an example of

experimental probability. $P(\text{heads}) = \frac{42}{100} = 0.42 = 42\%$; $P(\text{tails}) = \frac{58}{100} = 0.58 = 58\%$.

3. What is theoretical probability?

Answer: Theoretical probability is the number of favorable outcomes divided by the number of possible outcomes. $P(\text{Making Shot}) = \frac{\text{Number of Favorable Outcomes}}{\text{Number of Possible Outcomes}}$

4. Give an example of theoretical probability.

Sample Answer: If a fair coin is flipped, there are two equally likely possibilities—heads and tails. The

$P(\text{head}) = \frac{1}{2}$; $P(\text{tail}) = \frac{1}{2}$. If the coin is flipped 100 times, the theoretical probabilities are $P(\text{head}) =$

$$\frac{50}{100} = 0.50 = 50\%; P(\text{tails}) = \frac{50}{100} = 0.50 = 50\%.$$

Teacher Tip: Depending on your students' experience with probability, you might want to ask the following questions:

1. What is a simulation?

Answer: A simulation is a procedure for answering questions about a real world problem by conducting an experiment that closely resembles the real situation.

2. Why do mathematicians use simulations?

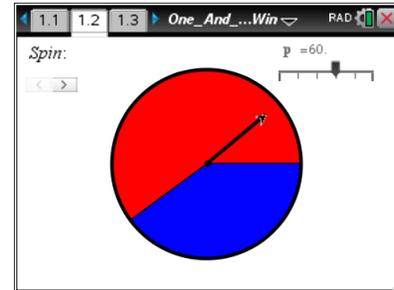
Answer: Simulations are conducted when it is too dangerous, too complex, or too expensive to manipulate the real situation.



Teacher Tip: Group students into pairs to gather experimental data using the spinner on Page 1.2. Each pair of students will gather data from one TI-Nspire CX.

Move to page 1.2.

Your teacher will divide the class into groups. On Page 1.2, you see a spinner divided into a blue area and a red area. You will use the spinner to compare experimental and theoretical probabilities for landing in the red area representing 60% of the area of the circle.



- The slider p stands for the probability the spinner will land in the red region which is measured as a percent.
 - You can use the slider to change the percentage of the area shaded red, and you can use the right arrow to spin.
5. Begin by dragging the slider to the right from $p = 0$ to $p = 100$. Record your observations.

Sample Answers: When the $P(\text{red}) = 0\% = 0$, the entire area of the circle is blue. When the $P(\text{red}) = 100\% = 1$, the entire area of the circle is red. All additional $P(\text{red})$ are between 0 and 1.

6. Move the slider so $p=60$. Record the following information into the table below:
- Predict the number of times out of 10 spins that the spinner will land on red.
 - Spin the spinner 10 times, and record the results in the table. One person can spin, and another person can record the spins landing on red with tallies and total the tallies.
 - Calculate the experimental probability for your group.
 - Calculate the theoretical probability for $P(60)$.
 - After the class outcomes have been recorded, record the total number of class spins landing in the red area.
 - Calculate the experimental probability for the class.

Sample Answers:

P(red)	Predicted Outcomes Landing on Red	Actual Outcomes Landing on Red	Your Group Experimental Probability	Theoretical Probability	Actual Class Outcomes	Class Experimental Probability
60%	5	 = 8	$\frac{8}{10} = .8$	$\frac{60}{100} = \frac{6}{10} = .6$	$\frac{68}{120}$	$\approx .567$



Teacher Tip: Use poster board, a document camera, etc. to aggregate the class data. If there are 24 students in class, there could be 12 pairs of data. If the groups report outcomes of 5, 4, 8, 4, 6, 4, 6, 6, 6, 7, 6, 6 for $P(\text{red}) = 60\%$, then $P(\text{red})$ for the class is approximately .567. Students can use Scratchpad  to calculate probabilities if necessary.



TI-Nspire Navigator Opportunity: *Class Capture, Live Presenter, and Quick Poll*

See Note 1 at the end of this lesson.

7. After each group has reported their results and the table is complete, compare and contrast the outcomes generated by your group with the class outcomes. Which set of outcomes were closer to the theoretical and why?

Answer: The experimental probability from the class data should be closer to the theoretical probability because the number of trials has increased.

Teacher Tip: Depending on the experience of your students with probability, you might want to ask the following question:

1. What other objects could be used to set up this simulation?

Possible Answers: To simulate a 60% (3 out of 5) probability of landing on red, the following could be used:

- 1) A spinner divided into ten equal sections. Sectors 1, 2, 3, 4, 5, and 6 could represent red; sectors 7, 8, 9, and 10 could represent blue.
- 2) A five-sided number cube could be used with three sides representing red and the other two sides representing blue.
- 3) Six red cubes and 4 blue cubes could be placed in a brown paper sack and drawn out one at a time. After each draw, the cube would be replaced and the bag shaken before the next draw.

Berryville High School is playing Harrison High School for the State Basketball Championship. The score is 78-79 in favor of Berryville High School. With one second left, a player from Berryville High School fouls Terry, a player from Harrison High School. Terry is a 60% free throw shooter, and he goes to the line for a “one and one” foul shot situation. Is the game likely to end in a tie, a win, or a loss for Harrison High School?

Teacher Tip: Before beginning the activity ask students questions to determine their understanding of the game of basketball. Possible questions:



What is considered a good free throw percentage?

Answer: Answers will vary, but any percentage of 75% is usually considered good.

What does it mean to be a 60% free throw shooter?

Answer:

For basketball players, the shooting percentage is based on a lot of statistical data. A 60% free throw shooter on average has made 3 out of 5 shots. In other words, a 60% shooter does not necessarily make 60% of their shots in every game; but on average over a large number of shots, he or she will make close to 60%.

What is a “one and one” free throw situation?

Answer: The player is guaranteed one shot. If that shot is made, the player is given a second attempt to make a shot.



TI-Nspire Navigator Opportunity: Quick Poll

See Note 2 at the end of this lesson.

8. Record your prediction whether the game will end in a win, a loss, or a tie below.

Prediction _____

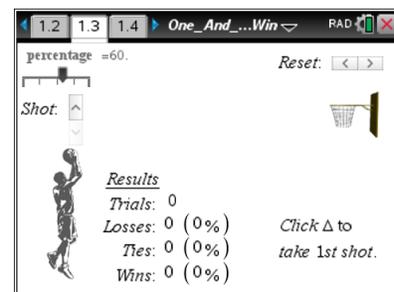


TI-Nspire Navigator Opportunity: Quick Poll

See Note 3 at the end of this lesson.

Move to page 1.3.

9. Be sure the slider percentage is set to 60.
 - Click the shot Δ to begin the trial.
 - If the shot is a miss, the game is lost, and it's time for a new trial.
 - If the shot is made, a message appears to click the shot Δ to take a second shot.
 - Repeat this process for ten trials. The results of the trials are recorded and totaled on Page 1.3.
 - To conduct another set of trials, click Reset to set the Trial counter to 0.





Teacher Tip: Create a table similar to the ones below on the white board, poster board, etc. for students to record their group data and aggregate the class results.

10. Record your group results in the table below, and calculate the experimental probabilities:

Sample Answers:

Group Results:

Trials	10	
		Experimental Probabilities
Losses	2	$\frac{2}{10} = .2$
Ties	1	$\frac{1}{10} = .1$
Wins	7	$\frac{7}{10} = .7$



TI-Nspire Navigator Opportunity: *Class Capture, Live Presenter, and Quick Poll*

See Note 4 at the end of this lesson.

11. After the class results have been aggregated, record those results in the table below, and calculate experimental probabilities:

Sample Answers:

Class Results:

Trials		
		Experimental Probabilities
Losses	53	$\frac{53}{120} \approx .442$
Ties	23	$\frac{23}{120} \approx .192$
Wins	44	$\frac{44}{120} \approx .367$

12. Compare and contrast the class results from the 60% spinner simulation and the class results from the simulation for the 60% free throw shooter:

Similarities:

Differences:

Sample Answers: Answers will vary, but the results for each simulation should be close.



13. Do you want to change your prediction of whether the game will end in a win, a loss, or a tie for Harrison High School? Please record your current prediction about the outcome of the basketball game between Berryville and Harrison High below.

Prediction _____

In addition to simulations, area models are often used to predict outcomes of real world events. Since our problem involves percentages, a 10 x 10 grid would be a good model for us to consider.

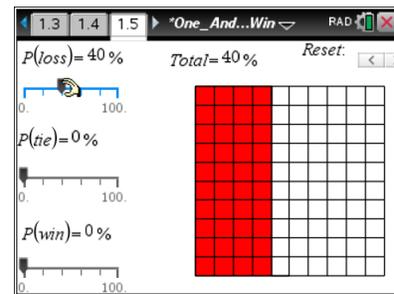


TI-Nspire Navigator Opportunity: Quick Poll

See Note 3 at the end of this lesson.

Read the directions on page 1.4 and move to page 1.5.

14. The previous simulations provided data we used to compare experimental and theoretical probabilities. Now, we want to consider theoretical probabilities with an area model. Out of 100 attempts to make the first free-throw shot, we expect a 60% free throw shooter to miss _____ shots.



Answer: 40

Tech Tip: Until the grid is filled, the total will be less than 100; so students will need to realize that they must fill the entire grid.

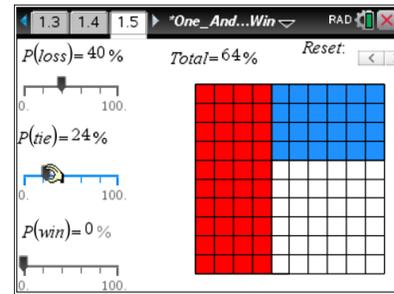
15. Move the P(loss) slider to represent the missed shots on the first attempt. What does the model currently show?

Answer: The model shows the theoretical probability of a 60% free throw shooter making a shot in 100 attempts. Theoretically, the shooter should make 60 baskets out of 100 attempts which are shown in white and should miss 40 out of 100 attempts which are shown in red. This model illustrates the probability the shooter will miss the first shot of the “one and one” and Berryville will win the game.



16. Out of 60 attempts to make the second shot of a “one and one” situation, how many shots do we expect a 60% free throw shooter to miss?

Answer: 40% of 60 = 24



17. Move the P(tie) slider to represent the number of shots missed on the second attempt of the “one and one” situation. How does the model represent the 60% free throw shooter?

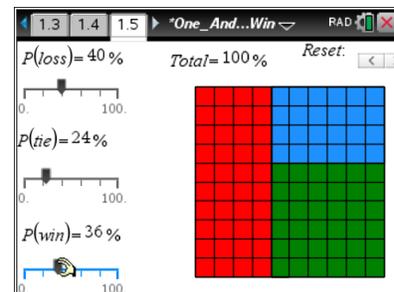
Answer: The blue squares indicate the 60% free throw shooter is expected to miss 24 out of every 60 attempts on the second shot. The blue squares show the probability the game will end in a tie; P(tie) is 24%.

18. Out of 60 attempts to make the second shot of a “one and one” situation, how many shots do we expect a 60% free throw shooter to make?

Answer: 60% of 60 = 36

19. Move the P(win) slider to represent the number of shots made on the second shot of the “one and one” situation. How does the model represent the 60% free throw shooter?

Answer: The green squares indicate the 60% free throw shooter is expected to make 36 out of every 60 attempts on the second shot. The model shows there is a 36% chance that Harrison will win the game.



20. What type of probability was represented by the area model? Why?

Answer: Theoretical probability because there was no experiment or simulation. All possible outcomes were considered.



TI-Nspire Navigator Opportunity: Class Capture, Live Presenter, and Quick Poll

See Note 4 at the end of this lesson.



Extension:

Ask students to pick a high school or college player and research his or her free throw shooting percentage and substitute that information into the problem. (Be sure to have students consider both male and female athletes). Students might choose to use their own personal statistics and/or those of their teammates. Be sure students have the opportunity to communicate their results to the class.



TI-Nspire Navigator Opportunity: Live Presenter

See Note 5 at the end of this lesson.

Wrap Up

Upon completion of the lesson, the teacher should ensure that students understand:

- A probability is a number between 0 and 1 that measures the likelihood of an event. A probability of 0 indicates that the event will not happen (impossible) and a probability of 1 indicates that the event is certain to happen.
- Probability deals more with long-term trends than with outcomes of individual events.
- As more data are gathered, the experimental probability can be expected to approach the theoretical probability.

Assessment

1. Have students describe different models that could be used for simulations related to this problem other than a spinner or technology.
2. Change the free throw shooting percentage and ask students to give the theoretical probability of winning, losing, or tying the game.



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Note 1

Class Capture, Live Presenter, and Quick Poll

Use Class Capture and Live Presenter to discuss student results. Use Quick Poll to send students a Lists & Spreadsheets page to aggregate the class data.

Note 2

Quick Poll

Use Quick Poll to assess students' current understanding of probability. In addition to the above suggested questions and to reviewing vocabulary, students can be asked to answer questions similar to the following:

- What is the $P(6)$ on one die? ($1/6 = .16\overline{6} = 16\overline{2/3}\%$)
- What is the $P(\text{sum of } 11)$ on two die? ($2/36$ or $1/18$ which is approximately $.056$ or 5.6%)
- What is the $P(\text{sum of } 1)$ on two die? (0)
- What is the $P(\text{product of } 1)$ on two die? ($1/36$)
- Name an event with a zero probability. (see above)
- Name an event with a probability of 1. (The outcome of tossing a penny will be a head or a tail.)

Note 3

Quick Poll

Have students use Quick Poll to indicate their prediction on whether the game will end in a win, a loss, or a tie.

Note 4

Class Capture, Live Presenter, and Quick Poll

Use Class Capture to view screens produced by each pair, and use Live Presenter to discuss the results. Use Quick Poll to send students a Lists and Spreadsheet page to aggregate the class data on Loss, Tie, and Win results.

Note 5

Class Capture, Live Presenter

Use Class Capture and Live Presenter to show student screens and debrief their results.