Building Concepts: Unequally Likely Outcomes

TEACHER NOTES

Lesson Overview

In this TI-Nspire lesson students investigate chance processes and generate probability models for events that are not equally likely. They use simulation to collect data to estimate probabilities. By the end of this lesson students should be able to use their experimental results and the theoretical probabilities to explain why the events in a chance process are or are not equally likely.

Not all outcomes of a chance event are equally likely.

Learning Goals

1. Recognize a chance event in which the outcomes are not equally likely;
2. find the probabilities of outcomes from a chance event where the outcomes are not equally likely.

Prerequisite Knowledge

Unequally Likely Outcomes is the fourteenth lesson in a series of lessons that explore statistics and probability. This lesson builds on the concepts of the previous lessons. Prior to working on this lesson students should have completed *What is Probability?* and *Probability, Diagrams, and Tables*. Students should understand:

- that the probability of an event is between 0 and 1;
- how to organize a list of all possible outcomes of a chance experiment involving compound events;
- how to find the probability of an outcome involving compound events.

Vocabulary

- **equally likely:** events that have the same probability of occurring
- **probability:** the chance that something will happen; how likely it is that an event will happen

Lesson Pacing

This lesson should take 50–90 minutes to complete with students, though you may choose to extend, as needed.

Lesson Materials

- Compatible TI Technologies:

  TI-Nspire CX Handhelds, TI-Nspire Apps for iPad®, TI-Nspire Software
- Unequally Likely Outcomes_Student.pdf
- Unequally Likely Outcomes_Student.doc
- Unequally Likely Outcomes.tns
- Unequally Likely Outcomes_Teacher Notes
- To download the TI-Nspire activity (TNS file) and Student Activity sheet, go to http://education.ti.com/go/buildingconcepts.

Class Instruction Key

The following question types are included throughout the lesson to assist you in guiding students in their exploration of the concept:

Class Discussion: Use these questions to help students communicate their understanding of the lesson. Encourage students to refer to the TNS activity as they explain their reasoning. Have students listen to your instructions. Look for student answers to reflect an understanding of the concept. Listen for opportunities to address understanding or misconceptions in student answers.

Student Activity: Have students break into small groups and work together to find answers to the student activity questions. Observe students as they work and guide them in addressing the learning goals of each lesson. Have students record their answers on their student activity sheet. Once students have finished, have groups discuss and/or present their findings. The student activity sheet can also be completed as a larger group activity, depending on the technology available in the classroom.

Deeper Dive: These questions are provided for additional student practice, and to facilitate a deeper understanding and exploration of the content. Encourage students to explain what they are doing and to share their reasoning.

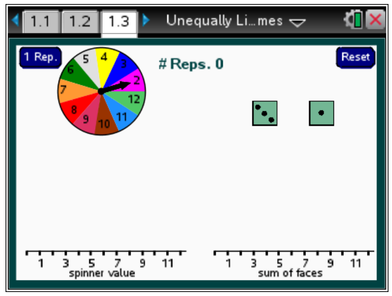
Mathematical Background

Determining the probability of an outcome can often be confusing. For example, one typical misconception is: when given two possible outcomes, the outcomes are equally likely. Thinking through different situations can illustrate that this belief is wrong: e.g., an all-star basketball player is not as likely to miss a free throw as to make a free throw; a thumb tack is not as likely to land with the point up as it is to land with the point on its side; there is not a 50/50 chance of rain every day. After the basics of probability are understood, students should experience setting up a model and using simulation (by hand or with technology) to collect data and estimate probabilities for a real situation where the outcomes are not equally likely. If possible, they should also investigate the theoretical probabilities.

Part 1, Page 1.3

Focus: Students will recognize the difference between outcomes of a chance event that are equally likely and those that are not.

On page 1.3 students spin a spinner with 11 equally spaced sections and toss two number cubes. The number on which the spinner stops is displayed on the number line below the spinner, and the sum of the faces on the two number cubes is displayed on the number line below the cubes.



The total number of repetitions is displayed on the top middle of the screen.

1 Rep spins the spinner and tosses the dice one time.

Reset resets the page and clears the number lines.

TI-Nspire Technology Tips

menu accesses page options.

enter animates the spinner and number cubes for one rep.

ctrl del resets the page.

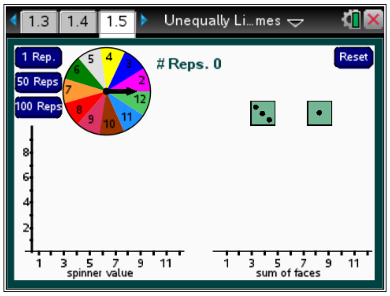
Class Discussion

The following questions use simulation to develop the idea of unequally likely outcomes and contrast them to a similar event where the outcomes are equally likely.

Have students…	**Look for/Listen for…**
Page 1.3 displays a spinner and two number cubes.	
• ***Describe each.***	Answer: The spinner is divided into 11 equal sections with the numbers 2 to 12; the number cubes show a three and a one.
• ***Select 1 Rep and describe what happens.***	Answer: The number cubes are rolled, and the sum of the faces, for example 8, is plotted on the number line below the number cubes. The spinner goes around, and the number of the section in which it stops, for example 11, is plotted on the number line below the spinner.
• ***Select 1 Rep four more times. Explain what the dots on the two number lines represent.***	Answers may vary. For example, in five spins the spinner landed on 7 three times, 9 once, and 11 once. In five tosses of the number cubes, the sum of the faces on the cubes was 4 once, 7 three times, and 8 once.

Part 1, Page 1.5

Focus: Students will recognize the difference between outcomes of a chance event that are equally likely and those that are not.



On page 1.5, the outcomes for each of the spins/tosses are displayed on the corresponding number lines. The highlighted dot in each plot represents the last outcome. The total number of repetitions is displayed on the top middle of the screen

Reset resets the page and clears the number lines.

1 Rep, 50 Reps, 100 Reps spins the spinner and tosses the number cubes once, 50 times or 100 times, respectively.

TI-Nspire Technology Tips

tab toggles between 1, 50, and 100 reps.

enter activates selected number or reps.

ctrl del resets the page.

Class Discussion

The following question asks students to think about what *equally likely* means in terms of chance events. Assume the number cubes to be fair and not weighted toward one side or another. The distribution of values for the spinner will approach a uniform or rectangular distribution but will not settle into one where the exact number of each outcome is the same because of the variability in the chance process. Students may conjecture that the most likely sum of the faces of the two number cubes will be 7, which is addressed in Part 2.

Have students…	Look for/Listen for…
***On page 1.5 select* 50 Reps.**	
• ***Describe the distributions of the outcomes for each rep.***	Answers may vary. One example: most of the time the spinner landed between 7 and 11. The typical sum on the faces of the number cubes was between 5 and 8.
• ***Select* 50 Reps *again and compare the new distributions.***	Answers may vary. One example: the spinner doesn't seem to be landing on any particular set of outcomes, while the sum of the faces on the number cube seems to be getting mound shaped around 7.
• ***Select* 100 Reps*. How have the distributions changed?***	Answers may vary. The outcomes for the spinner are kind of flat with no one value happening more than 20 times. The distribution of the sums of the faces on the number cube is getting more mound-shaped and symmetric around 7.

Class Discussion (continued)

• ***Make a conjecture about what you think the distributions will look like after 500 spins. Then check your conjecture using the TNS activity.***	Answers may vary. The frequency for each of the outcomes on the spinner are increasing and are all between about 30 and 50, but with no pattern in the distribution; the distribution of the sums of the faces on the number cube will become more mound shaped and symmetric around 7.

Use your distributions from the previous question to answer the following.

• ***What region is the spinner most likely to land on? Least likely?***	Answers may vary. In one example, the most likely was 2 and the least likely was 12.
• ***What sum is most likely to occur on the faces of two number cubes? Least likely?***	Answers will vary. 7 should be the most likely sum and either 2 or 12 should be the least likely.
• ***Reset and do another 500 spins. How do your answers to the two previous questions change?***	Answer: This time the spinner was most likely to land at 3 and least likely to land at 10; the most likely sum of the faces was 7 and the least likely was 12 with 2 the next least likely.

Student Activity Questions—Activity 1

1. Sometimes the outcomes for a chance event are equally likely to occur and sometimes they are not.

a. Do you think the spinner is equally likely to land on any of the sections 2 to 12? Why or why not?

Answers may vary. Yes, because the sections appear to be equal in area and so the spinner should have the same chance of landing on any of them. The distribution shows this by kind of jumping around.

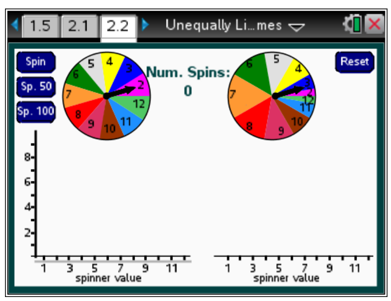
b. Do you think that all of the possible sums of the faces of the two number cubes will be equally likely? Why or why not?

Answers may vary. No, because the sum of 7 happened the most often and a sum of 2 and of 12 did not happen very often.

Part 1, Page 2.2

Focus: Students will recognize the difference between outcomes of a chance event that are equally likely and those that are not.

Page 2.2 has the same functionality as page 1.5. Dragging or using the up/down arrow keys moves the grey bar at the bottom of the left axis vertically.



Class Discussion

Have students…	Look for/Listen for…
Reset *the page. Note the horizontal bar at the bottom of the axis on the left*.	
• ***Generate 100 repetitions. If each outcome has the same chance of occurring, what is an estimate of the frequency for each outcome in the 100 repetitions?***	Answer: There are 11 possible outcomes, and if each has an equal chance of occurring it would be $\frac{100}{11}$ or about 9.
• ***Move the horizontal bar to your estimate from the question above. Describe the variability around your estimate.***	Answers may vary. The bar would be at $\frac{100}{11}$ or about 9. In one example, five of the outcomes were one or two above 9, 3 outcomes were at 9, and 3 that were one to three below 9.
• ***Generate 500 repetitions, then answer the question above for this distribution of outcomes.***	Answer may vary. The bar would be at $\frac{500}{11}$ or about 45. In one example, three of the outcomes were slightly below 45 and 1 was about 7 below; 1 was at and the others were 1 or 2 above 45.
• ***The theoretical distribution for outcomes such as these, when they are all equally likely, is called a uniform distribution. Explain why this might be called a "rectangular" distribution.***	Answers may vary. In a uniform distribution all outcomes will have exactly the same expected frequencies. This would make a rectangular shape, which is what the simulated distributions seem to be approaching.

Student Activity Questions—Activity 2

1. **Page 2.2 shows two spinners.**

   a. **Do you think that both spinners are equally likely to land on any of the numbers 2 to 12? Why or why not?**

   Answer: No, the spinner to the right has sections that are not equal in area, some like 2, 3, 11, and 12 are smaller than others, so the spinner is not as likely to land on them as often as on the ones with the larger area like 5, 6, or 7. The parts of the circle are all the same for the spinner on the left, so overall the spinner is likely to land on any one of them about the same amount of spins.

Student Activity Questions—Activity 2 (continued)

b. **Check your answer to the question above by spinning the spinners enough times and repeating the experiment to be fairly confident of your claim.**

Answer: When I had 500 spins, the outcomes for the spinner on the left varied, but no one outcome seemed really more likely than the others. The outcomes on the spinner on the right matched my conjecture—more 7s than any of the other numbers, then 6s and 5s with a small number of 2s and 12s.

2. **Decide which of the claims below are correct and which are not. What would you say to each student if you disagree?**

a. **Sal claims that if something has two possible outcomes, each one has $\frac{1}{2}$ chance of occurring.**

Answer: This is not true. Students may give an example such as for most students, the probability of passing a test is not a 50% chance of passing and a 50% chance of failing.

b. **Tilani claims that if all of the outcomes of a chance event are equally likely, then the distribution of the outcomes over many, many repetitions of the event should be somewhat rectangular in shape, with all of the outcomes having approximately the same frequency of occurrence.**

Answer: Tilani is correct.

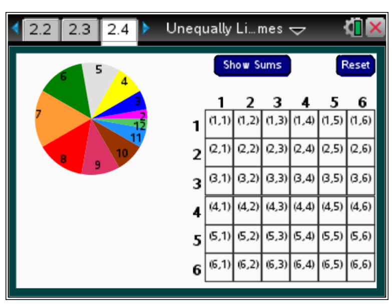
c. **Jon claims that the sums of the faces when tossing two number cubes are not equally likely to occur.**

Answer: Jon is correct.

Part 2, Page 2.4

Focus: Students will find the theoretical probability of getting a given sum when tossing two number cubes.

On page 2.4, students select a number on the spinner or keypad which then displays and highlights in the table the cells with the pairs of number cubes whose faces sum to that number.



TI-Nspire Technology Tips

menu accesses page options.

ctrl del resets the page.

Show Sums shows sums of number cubes in the table.

Show Pairs displays ordered pairs in the table.

Reset clears selections.

Class Discussion

Questions in this section investigate the theoretical probability of getting a certain sum when you toss two number cubes.

Have students…	Look for/Listen for…
Go to page 2.4. Activity 13* Probability, Diagrams, and Tables*, investigates the probability of compound events. One example of a compound event is to toss two number cubes. Use your knowledge of compound events to answer the following questions.	
• ***What are the possible outcomes for the first event, tossing one number cube?***	Answer: the numbers 1 to 6.
• ***What are the possible outcomes for the second event, tossing the second number cube?***	Answer: the numbers 1 to 6.
• ***If you were to make a table or a tree diagram for the possible outcomes for tossing both number cubes, what do you think it might look like?***	Answers may vary: a table with 6 rows for one cube and 6 columns for the other, each with the numbers 1 to 6.
• ***How many possible outcomes will there be?***	Answer: 36
Use the skills developed in* Activity 12 What is Probability?** ***to answer the following questions.	
• ***What is the probability associated with the cell (3, 4)? What does that cell (3, 4) represent?***	Answer: The probability is $\frac{1}{36}$ because there are 36 outcomes from tossing the two number cubes, and the cell (3, 4) represents getting a face that shows 3 on the first number cube and one that shows 4 on the second.
• ***What is the probability of getting a three on one cube and a four on the other?***	Answer: $\frac{2}{36}$ because (3, 4) and (4, 3) both satisfy the condition.
• ***What is the probability of tossing both number cubes and have the faces match? Explain how you know.***	Answer: $\frac{6}{36}$ or $\frac{1}{6}$, because six of the 36 cells have matching faces.
• ***Do you think the probabilities of getting the faces for any one cell when you toss the two cubes are equally likely? Why or why not?***	Answer: Yes because there is 1 out of 36 ways to get the faces in each cell.

Student Activity Questions—Activity 3

1. On page 2.4, select Show Sums.

a. Describe what happened. Where did the numbers come from?

Answer: Each cell now has one number that shows the sum of the faces on the two number cubes. If you rolled a 3 on one cube and a 4 on the other, the sum of the faces would be 7.

b. How many ways can you get a sum of 9 when you roll the two cubes? Select the number on the spinner that corresponds to 9 to check your thinking.

Answer: You can get a 9 four ways: adding 3 and 6; 6 and 3; 5 and 4; 4 and 5. This checks with the four 9s that show up on the table.

c. What sums are possible when you toss two number cubes? Are each of the sums equally likely? Use the table to help explain why or why not.

Answer: Possible sums go from 2 to 12. No, they are not equally likely because there is only 1 way to get a sum of 2 or 12, but there are six ways to get a sum of 7.

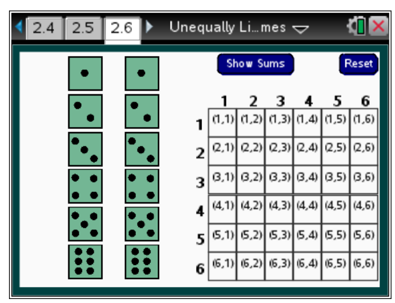
2. Use Show Sums and Show Pairs on the table to find the probability the faces sum to

a. 7 **b. 3** **c. 5 or 9** **d. an even number**

Answer: a. $\frac{6}{36}=\frac{1}{6}$, b. $\frac{2}{36}=\frac{1}{18}$, c. $\frac{8}{36}=\frac{2}{9}$. d. $\frac{18}{36}=\frac{1}{2}$

Part 2, Page 2.6

Focus: Students will find the theoretical probability of getting a given sum when tossing two number cubes.



On page 2.6, students select a number cube from each column which highlights the corresponding ordered pair in the appropriate cell in the table.

Pair and **Pair Continued** highlight the corresponding ordered pair in the table and the appropriate number cubes from each column.

Class Discussion

Have students…	Look for/Listen for…
Go to page 2.6.	
• ***From the left column of number cubes select the number cube with 2 dots and from the right column of number cubes select the number cube with 3 dots. Which cell in the table does this correspond to? What is the probability you will get this pair when you toss the cubes?***	Answer: This corresponds to the cell (2, 3) and the probability you will get this pair is $\frac{1}{36}$.

Building Concepts: Unequally Likely Outcomes

TEACHER NOTES

Class Discussion

• ***From the left column of number cubes select the number cube with 3 dots and from the right column of number cubes select the number cube with 2 dots. Which cell in the table does this correspond to? What is the probability you will get this pair when you toss the cubes?***	Answer: This corresponds to the cell (3, 2) and the probability you will get this pair is $\frac{1}{36}$.
• ***What is the probability you will toss two number cubes and have a 2 on one face and a 3 on the other face? Explain your answer.***	Answer: $\frac{2}{36}$ or $\frac{1}{18}$ because you can have (2, 3) or (3, 2).
• ***What is the probability you will toss two number cubes that both show 6s? How is your answer different from your answer to the previous question?***	Answer: $\frac{1}{36}$. This is different because there is only one way to get sixes on both number cubes, while there are two ways to get a 2 and a 3.

Student Activity Question—Activity 4

1. **In which of the following situations do you think the outcomes will be equally likely? Explain your reasoning.**

   a. **Your grandmother will make or miss a free throw shot.**

   b. **A professional basketball player will make or miss a free throw shot.**

   c. **You observe a heads or tails when you toss a coin.**

   d. **You toss a number divisible by 3 or not when you toss a number cube.**

   Answer: Only c) has equally likely outcomes. Typically, most people will not make one out of every two free throw shots for a 50/50 chance. And there are two numbers divisible by 3 when you toss a number cube and four that are not so the probability of getting a number divisible by 3 would be $\frac{2}{6}$ or $\frac{1}{3}$.

Deeper Dive

Imagine drawing from a deck of 10 cards numbered 1 to 10. If you draw one card, which of the following descriptions are equally likely? Justify your reasoning.

- ***prime or even***

  Answer: not equally likely, there are five even numbers and only four prime numbers from 1 to 10.

- ***greater than 5 or even***

  Answer: equally likely because there are five even numbers and five numbers greater than 5 in the numbers from 1 to 10.

- ***a power of 2 or a multiple of 3***

  Answer: not equally likely because there are four powers of 2 {1, 2, 4, 8} and three multiples of 3 {3, 6, 9}

- ***exactly two different prime factors or a perfect square***

  Answer: not equally likely because there are three perfect squares {1, 4, 9} and there are two numbers with two different prime factors {6, 10}.

Deeper Dive — Page 2.4

Use the table on page 2.4 to help you decide if each of the following is correct.

- ***The probability of getting two 3's is $\frac{2}{36}$ or $\frac{1}{18}$ because there are two ways to get two 3's, one on each cube.***

  Answer: This is not correct as the only way to get two 3's is from (3, 3), which you can see on the table.

- ***The probability of getting a 2 on either cube can be figured out by finding the ways to get 2s in a column and then doubling for the rows.***

  Answer: This is not quite correct. While there are six columns with a 2 and six rows with a 2, one of the cells (2, 2) is in both the row and the column so it cannot be counted twice and thus the answer is one less than $\frac{6}{36}$ doubled or $\frac{11}{36}$

  .

- ***The table of sums is symmetric around the ways to sum to 7, with the number of ways to get sums greater than 7 mapping onto the number of ways to get sums less than 7.***

  Answer: This is correct because the number of ways to get 2 is the same as the number of ways to get 12; number of ways to get 3 the same as the number of ways to get 11 and so on.

Deeper Dive — Page 2.4 (continued)

- ***To find the number of sums that are even you could count the numbers on all the diagonals of the sums going from the top left corner to the bottom right corner "parallel" to and including the diagonal from (1, 1) to (6, 6), then from (3, 1) to (6, 4) and so on.***

Answer: This is correct because in those diagonals the starting number is paired with another odd number so the sum is even.

Deeper Dive

Use the skills developed in this activity and* Activity 13: Probability, Diagrams, and Tables *to answer the following questions.

Look at an object about 10 feet away with both eyes through a hole made with your thumb and forefinger. Then close your right eye and see if you can still see the object through the hole. Repeat closing your left eye. You are "right eyed" if you can still see the object with your left eye closed. In a certain region of the world, $\frac{2}{3}$ of the people are right eyed. In addition, $\frac{1}{6}$ of the people have red hair, $\frac{1}{3}$ are blondes, $\frac{1}{4}$ have brown hair, and $\frac{1}{4}$ of them have black hair. What is the probability that a person chosen by chance from that country will

- ***be right eyed and have blonde hair?***

  Answer: $\left(\frac{2}{3}\right)\left(\frac{1}{3}\right)=\frac{2}{9}$

- ***be right eyed and have either brown or black hair?***

  Answer: $\left(\frac{2}{3}\right)\left(\frac{1}{4}\right)(2)=\frac{1}{3}$

- ***have blonde hair?***

  Answer: $\frac{1}{3}$

- ***is not right eyed and has black hair?***

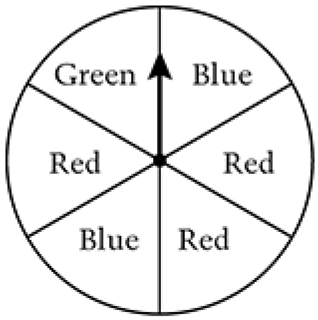
  Answer: $\left(\frac{1}{3}\right)\left(\frac{1}{4}\right)=\frac{1}{12}$

What is the most likely outcome for the two events: right eyed or not and color hair? The least likely? Explain your thinking.

Answer: The most likely is being right eyed and blonde because each of those has the largest probability for the choices. The least likely outcome is not being right eyed and having red hair because those are smallest probabilities for the choices.

Sample Assessment Items

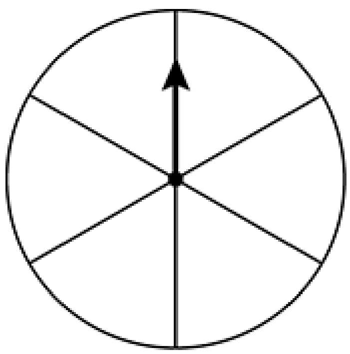
After completing the lesson, students should be able to answer the following types of questions. If students understand the concepts involved in the lesson, they should be able to answer the following questions without using the TNS activity.



1. Are the outcomes in the spinner equally likely? Why or why not?

   Answer: no because the probability of getting each color is not the same: the probability of getting a red is $\frac{3}{6}$, blue is $\frac{2}{6}$ and green is $\frac{1}{6}$.

2. The circular spinner shown below is divided into 6 congruent sectors. The sectors are yellow or blue.



   Label each of the sectors either yellow (Y) or blue (B) so that the probability of spinning the arrow once and landing on yellow and the probability of landing on blue are not equally likely.

   Adapted from NAEP 2011 grade 8

   Answers may vary. Any combination that does not have 3 yellow and 3 blues will work.

3. What is the probability of tossing two dice each with four sides numbered 1 to 4 and getting

   a. a sum of 7

   Answer: $\frac{2}{16} = \frac{1}{8}$

   b. a sum of 3

   Answer: $\frac{2}{16} = \frac{1}{8}$

4. In a bag of cards $\frac{1}{6}$ are green, $\frac{1}{12}$ are yellow, $\frac{1}{2}$ are white, and $\frac{1}{4}$ are blue. If someone takes a card from the bag without looking, which color is it most likely to be?

   a. white b. blue c. green d. yellow

   TIMSS Population 2 Item Pool, 1994

   Answer: a) white

5. Each of the six faces of a cube is painted red or blue. When the cube is tossed, the probability of the cube landing with a red face up is $\frac{2}{3}$. How many faces are red?

   a. one b. two c. three d. four e. five

   TIMSS Population 2 Item Pool, 1994

   Answer: d) four

Building Concepts: Unequally Likely Outcomes

Student Activity Solutions

In these activities you will find the probabilities of outcomes from a chance event where the outcomes are not equally likely. After completing the activities, discuss and/or present your findings to the rest of the class.

Activity 1 [Page 1.5]

1. Sometimes the outcomes for a chance event are equally likely to occur and sometimes they are not.

   a. Do you think the spinner is equally likely to land on any of the sections 2 to 12? Why or why not?

   Answers may vary. Yes, because the sections appear to be equal in area and so the spinner should have the same chance of landing on any of them. The distribution shows this by kind of jumping around.

   b. Do you think that all of the possible sums of the faces of the two number cubes will be equally likely? Why or why not?

   Answers may vary. No, because the sum of 7 happened the most often and a sum of 2 and of 12 did not happen very often.

Activity 2 [Page 2.2]

1. Page 2.2 shows two spinners.

   a. Do you think that both spinners are equally likely to land on any of the numbers 2 to 12? Why or why not?

   Answer: No, the spinner to the right has sections that are not equal in area, some like 2, 3, 11, and 12 are smaller than others, so the spinner is not as likely to land on them as often as on the ones with the larger area like 5, 6 or 7. The parts of the circle are all the same for the spinner on the left, so overall the spinner is likely to land on anyone of them about the same amount of spins.

   b. Check your answer to the question above by spinning the spinners enough times and repeating the experiment to be fairly confident of your claim.

   Answer: When I had 500 spins, the outcomes for the spinner on the left varied, but no one outcome seemed really more likely than the others. The outcomes on the spinner on the right matched my conjecture – more 7s than any of the other numbers, then 6s and 5s with a small number of 2s and 12s.

2. Decide which of the claims below are correct and which are not. What would you say to each student if you disagree?

   a. Sal claims that if something has two possible outcomes, each one has $\frac{1}{2}$ chance of occurring.

   Answer: This is not true. Students may give an example such as for most students, the probability of passing a test is not a 50% chance of passing and a 50% chance of failing.

b. Tilani claims that if all of the outcomes of a chance event are equally likely, then the distribution of the outcomes over many, many repetitions of the event should be somewhat rectangular in shape, with all of the outcomes having approximately the same frequency of occurrence.

Answer: Tilani is correct.

c. Jon claims that the sums of the faces when tossing two number cubes are not equally likely to occur.

Answer: Jon is correct.

Activity 3 [Page 2.4]

1. On page 2.4, select Show Sums.

a. Describe what happened. Where did the numbers come from?

Answer: Each cell now has one number that shows the sum of the faces on the two number cubes. If you rolled a 3 on one cube and a 4 on the other, the sum of the faces would be 7.

b. How many ways can you get a sum of 9 when you roll the two cubes? Select the number on the spinner that corresponds to 9 to check your thinking.

Answer: You can get a 9 four ways: adding 3 and 6; 6 and 3; 5 and 4; 4 and 5. This checks with the four 9s that show up on the table.

c. What sums are possible when you toss two number cubes? Are each of the sums equally likely? Use the table to help explain why or why not.

Answer: Possible sums go from 2 to 12. No, they are not equally likely because there is only 1 way to get a sum of 2 or 12, but there are six ways to get a sum of 7.

2. Use Sum and Pair on the table to find the probability the faces sum to

a. 7 b. 3 c. 5 or 9 d. an even number

Answer: a. $\frac{6}{36}$, *b.* $\frac{2}{36}=\frac{1}{18}$, *c.* $\frac{8}{36}=\frac{2}{9}$, *d.* $\frac{18}{36}=\frac{1}{2}$

Activity 4 [Page 2.6]

1. In which of the following situations do you think the outcomes will be equally likely? Explain your reasoning.

   a. Your grandmother will make or miss a free throw shot.

   b. A professional basketball player will make or miss a free throw shot.

   c. You observe a heads or tails when you toss a coin.

   d. You toss a number divisible by 3 or not when you toss a number cube.

   Answer: Only c) has equally likely outcomes. Typically, most people will not make one out of every two free throw shots for a 50/50 chance. And there are two numbers divisible by 3 when you toss a number cube and four that are not so the probability of getting a number divisible by 3 would be $\frac{2}{6}$ *or* $\frac{1}{3}$.