Simulations for Compound Events

Objective

In this lesson, you will

Designing Simulations for Compound Events

Be sure the simulation and situation it models have _____ ratios of events to possible outcomes.

Steps to design a simulation for a compound event:

1. *Study the probabilities of the simple events that make up the compound event.*
2. *Identify a simulation in which the outcomes have the same probability as the events under consideration.*
3.
4. *Perform the simulation multiple times.*
5.
6. *Analyze the outcomes of the simulation.*

Lesson Activity

A survey shows that 50% of Americans exercise for 30 minutes a day at least three times a week.
Reba wants to estimate the probability that three randomly chosen people do not work out this much.

To simulate this situation with coin flips:

- Let heads represent a person who exercises the given amount and tails represent a person who doesn't.
- For each trial, flip the coin _____ times and note the results.
- If all the flips land on _____, it would mean that all three randomly selected people do not exercise as much as 50% of Americans do.

To simulate this situation using other methods:

- Use a spinner with four colored, equal-sized sections where purple colors represent a person who exercises the given amount and yellow colors to represent a person who doesn't.
- Use a random number generator where the numbers 0 to 4 represent a person who exercises the given amount and the numbers ____ to ____ represent a person who doesn't.

The simulation you choose depends on the probability values in the situation.

Example:
If the probability of an event happening is 40%, it ◯can ◯cannot be modeled with the flip of a coin because a coin flip has _____ equally likely outcomes, and the probability of each outcome is _____%.

Since 40% = $\frac{2}{5}$, use a simulation that has a multiple of _____ as the number of possible outcomes.

For example, use a number generator to generate the numbers from 0 to 9 (_____ possible outcomes). Match the numbers 0 to ____ to the event happening and the numbers 4 to ____ to the event not happening.

Question

Betty discovers that 40% of the items in the school cafeteria contain milk products. She wants to know the probability that the cafeteria serves three meals in a row containing milk products.

The ratio of food items containing milk products to those without milk is 40 : _____, or 2 : _____.

So, Betty's simulation should have a multiple of _____ possible outcomes.

Using a _____-section spinner:

- ✓ 2 sections represent items _____ milk products
- ✓ _____ sections represent items _____ milk products

Spin the spinner _____ times.

- ✓ If all the spins land on sections representing food items that contain milk products, it would represent the cafeteria serving three meals in a row containing milk products.

To find the relative frequency of the event, Betty needs to perform the simulation multiple times.

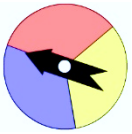
Using Simulations for Compound Events

To estimate a probability from a simulation:

1. Perform the simulation multiple times and record the results.
2. From the results, find the _____ frequency of the event,
3. Use the relative frequency as the estimate of the probability of the compound event.

$$\text{estimated probabilty} = \frac{\text{number of times an event occurs}}{\text{total number of trials}}$$

Example:
A survey showed that equal numbers of students in Cathy's school preferred baseball, basketball, and football. She wants to know the estimated probability that two randomly picked students prefer basketball.



Cathy modeled this situation using a spinner with three colored sections: red for basketball, blue for football, and yellow for baseball.

The table shows the results of spinning the spinner 50 times.

RR	BY	BB	RY	YR
YB	BR	RB	RB	YR
BY	BY	RR	YY	RB
RY	RR	YY	RB	RR
RB	BY	RR	BY	YB
RY	YB	YR	RB	RB
YR	RB	YB	YY	YR
BR	YB	YB	RB	RB
RB	RR	BB	YB	YR
YR	BB	YR	BY	BY

The event we're looking for is two students who prefer basketball.

That means in both spins, the spinner must land on the _____ section,

which appears as _____ in the table of results.

The table shows that this event occurs _____ times.

$$\text{estimated probability} = \frac{\text{number of times an event occurs}}{\text{total number of trials}} = \frac{\square}{50}$$

The estimated probability that two students picked at random both prefer basketball is approximately _____.

Example:
A bowl contains 500 yellow marbles, 1,000 red marbles, and 1,500 blue marbles. Use a simulation to find the probability that at least five marbles have to be drawn before a yellow marble is drawn.

1. Design a simulation for the scenario.
   - → The ratio of the number of marbles in the bag is 500 yellow : 1,000 red : 1,500 blue, or 1 : ____ : ____.
   - → The number of possible outcomes needs to be a multiple of _____, so a die can be used.
   - → Match the outcomes to rolling the different numbers on a die:

     1 = a _____ marble; 2 or 3 = a _____ marble; and 4, 5, or 6 = a _____ marble.
2. Use the simulation to estimate the probability of the event.
   - → The event is that at least _____ marbles have to be drawn before a yellow marble is drawn.
   - → For our simulation of rolling a die, the event is not rolling a 1 in any of the first _____ rolls.

     So, we need to perform the simulation in sets of _____.
   - → The event occurring is represented by the number ____ not appearing in the set of four rolls.
3. Calculate the estimated probability.
   - → The table shows the results of 25 trials.
   - → This event occurs 12 times.

2421	6114	5143	3642	5136
5236	6633	1642	5156	2226
4214	4451	1512	5555	4543
5662	1566	3236	2126	5162
3433	4662	3453	6114	3436

The probability that at least five marbles have to be drawn before a yellow marble is drawn is approximately _____.

When the event requires at least *n* outcomes (*n* is an integer) before a specific outcome occurs:

- ✓ The number of items per set would be _____.
- ✓ Define the event as occurring when the outcome _____ _____ occur anywhere in the set.

Question

Gina randomly chooses from three different games to play on her computer: game A, game B, and game C. She generated this table of random combinations to model the situation.

BB	CA	AC	BA	AC
AB	AC	BA	AC	CB
AB	AB	CC	AA	AC
BC	CA	BA	AA	BB
AA	BC	BA	CA	CC
CC	BA	CB	CB	AB
BC	BC	CC	BA	AA
CC	BC	CA	BA	CB
CC	AB	AB	AA	CA
BA	AB	BA	AA	AA

Find the probability of Gina playing at least three games before playing game A.

- → The phrase "at least three" means Gina would not play game A in the first _____ occurrences.
- → Search the table for all outcomes that do not have an ___.
- → Estimate the probability using the formula:

$$\text{estimated probability} = \frac{\text{number of times an event occurs}}{\text{total number of trials}} = \frac{\square}{\square}$$

The estimated probability that Gina plays at least three games before she plays game A is _____.

Summary

Mary claims that any compound event that can be simulated by rolling a die can also be simulated using a random number generator. Do you agree? Is the opposite (any compound event that can be simulated using a random number generator can also be simulated by rolling a die) true?