# Probability Simulations
**ID: 9327**

**Time required**
*45 minutes*

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## Activity Overview

*In this activity, students use the random integer (randInt) command to simulate probability experiments. They also graph the number of trials and corresponding probabilities to observe the Law of Large Numbers. Simulated experiments involve tossing a coin, spinning a spinner, and observing the sex of children in a family.*

*In an optional extension, students are challenged to create simulations in any way they find best to predict how many tosses, on average, it takes to toss two heads in a row.*

## Topic: Simulating Probability Experiments

- *Use experimental probabilities to predict theoretical probabilities.*
- *Use random integers to perform simulations.*
- *Explain the Law of Large Numbers.*

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## Teacher Preparation

- *This activity is designed to be used for students studying Statistics and Probability. It can also be used as an enrichment activity in an Algebra 2 class.*
- *Students should be familiar with finding a simple theoretical probability (number of favorable outcomes divided by total number of outcomes) in order to make comparisons with their simulated experimental probabilities.*
- *This activity is designed to have students explore **individually and in pairs**. However, an alternate approach would be to use the activity in a whole-class format. By using the questions found on the student worksheet, you can lead an interactive class discussion.*
- *Use your allocated class time to determine if students should expand their graphs at the end of Problems 1 and/or 2 to include more trials. Students can work together and combine results to save time.*
- ***To download the student worksheet, go to education.ti.com/exchange and enter "9327" in the keyword search box.***

## Associated Materials

- *ProbabilitySimulations_Student.doc*

## Suggested Related Activities

*To download any activity listed, go to education.ti.com/exchange and enter the number in the keyword search box.*

- *Law of Large Numbers: Adding It Up (TI-84 Plus family with TI-Navigator) — 4238*
- *To Toss or To Simulate? (TI-84 Plus family) — 11610*

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**Problem 1 – Rolling Heads**

In the first problem, students will use the random integer command (r**andInt**) to simulate trials of tossing a coin. A series of questions on the student worksheet will guide students to understanding what the random integer command does.

Students are to simulate different numbers of trials, recording the number and percent of heads for each experiment. They will use the **randInt** command with the following parameters:

**Randint(low bound, upper bound, number of trials)**

After students have completed the table on the first page of the student worksheet, they are to enter those numbers in list **L1** (number of trials) and **L2** (experimental probability).

Discuss with students why they each have different values in list L2.

Then students need to set up Plot1 to graph a scatter plot of L1 vs L2 and view the plot.

To see how the experimental probability relates to the theoretical probability, students are to draw a horizontal line at $y = 0.5$.
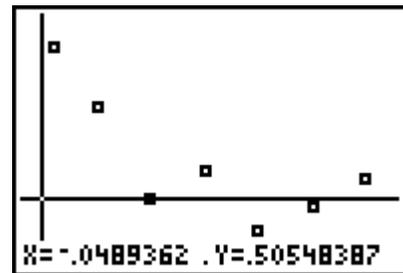
Discuss with students what they notice about the points surrounding the line as they move from left to right.

As students finish Problem 1, they should conclude that as the number of trials increases, the experimental probability becomes closer to the theoretical probability. Tell them that this is called the Law of Large Numbers.

**Problem 2 – Spinning a "2"**

In this problem, students will use the random integer command to simulate spinning a spinner with four sections. Once again, they are to complete the table on the second page of the student worksheet by conducting experiments with different numbers of trials.

On the scatter plot, students should graph the horizontal line *y* = 0.25, the theoretical probability of landing on a 2.

```
randInt(1,4,5)
     {4 3 2 1 4}
randInt(1,4,10)
{1 2 1 1 4 2 3 …
randInt(1,4,15)
{1 3 3 4 2 1 2 …
```

**Problem 3 – Exactly Two Girls**

In this problem, it is suggested that students use even and odd numbers to distinguish results in a simulation. Ask students how else they could distinguish the results. (They can use positive and negative numbers.)

Note: If students use the command **randInt(-9, 9, 5)**, to simulate a family with five children, they need to be sure to ignore any lines that contain a zero.

```
randInt(-9,9,2)
          {4 -3}
         {-5 -7}
         {-7 -6}
          {7 2}
         {-2 9}
```

**If using Mathprint OS:**

Students delete a line with a zero. Press the up arrow, until the output is highlighted and then press DEL.

```
randInt(-9,9,5)
   {3 6 1 -3 -5}
randInt(-9,9,5)
  {2 7 -7 -1 -1}
randInt(-9,9,5)
  {-4 6 9 0 -2}
```

**Problem 4 – Extension**

The extension is optional. If you opt for your students to do it, have students share and compare their methods and results with the rest of the class.

```
randInt(0,1,50)
{0 0 1 1 0 0 0 …
```

### *Solutions*

1. It gives a random integer from 0 and 1.

2. Sample: 0 = heads and 1 = tails

3. It gives the results for that many trials.

4. Sample: The percents start to hover around 0.5.

5. Sample: The points get closer to the line as *x* increases.

6. Sample: Yes, as the number of trials increases, the percents get closer to the theoretical value of 0.25.

7. Sample: Each line is a family and each number represents one of the two children.

**8-9.** Answers will vary.

10. Answers will vary. The theoretical probability is 0.3125.

11. Sample: about 5 times. I used **randInt(0, 1, 50)** to simulate 50 consecutive coin tosses. I counted the number of times it took to get the first second, third, etc pair of heads and took the average of those numbers.