

## To Toss or To Simulate?

ID: 11611

Time required  
20 minutes

## Activity Overview

*In this introductory activity, students will use the RandInt() command to simulate the tossing of a coin and the rolling of a die. They will collect data for several trials and use the information to investigate the Law of Large Numbers.*

## Topic: Simulations

- *Random Integers*
- *Experimental Probability*
- *Theoretical Probability*
- *Law of Large numbers*

## Teacher Preparation and Notes

- *This lesson is designed as a discovery lesson that is teacher led. It is paper-free, although a worksheet has been provided to help organize data collection.*
- *Prior to the lesson students should be able navigate through a document, including entering data in a spreadsheet and creating a scatter plot.*
- *Students will gather a large amount of data within the Lists & Spreadsheets applications. To speed up the handheld, have students delete the data for each problem before moving on to the next problem. It is recommended that the solution TI-Nspire file be opened using the TI-Nspire computer software.*
- ***To download the student and solution TI-Nspire documents (.tns files) and student worksheet, go to [education.ti.com/exchange](http://education.ti.com/exchange) and enter “11611” in the quick search box.***

## Associated Materials

- *TossSimulation\_Student.doc*
- *TossSimulation.tns*
- *TossSimulation\_Soln.tns*

## Suggested Related Activities

*To download any activity listed, go to [education.ti.com/exchange](http://education.ti.com/exchange) and enter the number in the quick search box.*

- *Probability Simulations (TI-Nspire technology) — 9328*
- *How Random! (TI-Nspire technology) — 8555*
- *How Random! (TI-84 Plus family) — 9291*
- *Rolling a Two (TI-Nspire technology) — 10211*
- *Law of Large Numbers: Adding it Up (TI-84 Plus family) — 4238*
- *Law of Large Numbers: A Weighty Decision (TI-84 Plus family) — 4236*

### Problem 1 – Tossing a coin

At the beginning of the activity define and discuss an event and sample space.

Students will be using the Random Integer (**randInt**) command to simulate the tossing of a coin. Ask them why sometimes a simulation is more practical than a hands-on experiment.

In this part of the activity, they will use 0 and 1 to represent the sides of the coin. However, any two consecutive integers can be used.

Students will compare the difference between entering the command `randInt(0,1)` five times and entering `randInt(0,1,5)`. They should see that they calculate the same thing but the latter does it all at one time.

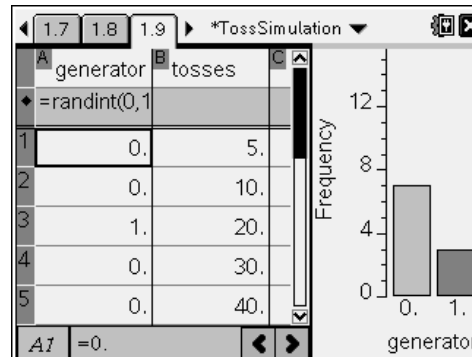
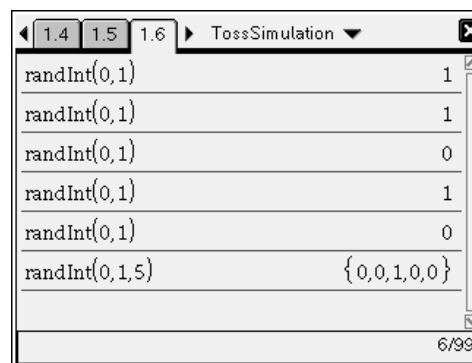
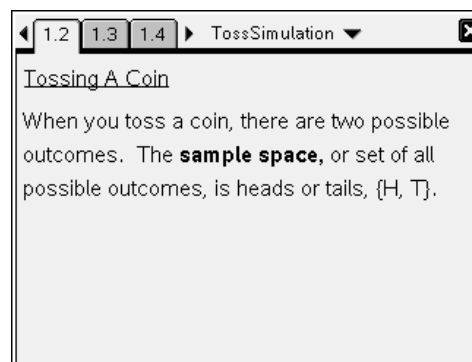
The syntax for the Random Integer command is **randInt(LowBound, HighBound)** OR **randInt(LowBound, HighBound, number of trials)**.

They can enter the command using the alpha keys or press **MENU > Probability > Random > Integer**.

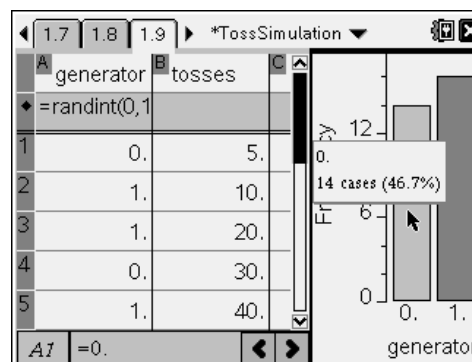
The experimental coin tossing will be simulated using the spreadsheet on page 1.9. Students may want to adjust the size of the columns so that they can see Columns A – C at the same time (**MENU > Actions > Resize > Resize Column Width**).

Students are to update third number of the **randInt** command in Column A to simulate the coin tossing of the number of trials given in Column B. They will then determine the number of heads by looking at the bar graph on the right side of the screen and record that number in the appropriate cell of Column C.

Before students perform the experiment for 10 and 20 trials, ask them what number of heads they expect to get. Then after running the experiment, poll the students to see how many heads they actually tossed. Discuss why the results differ.

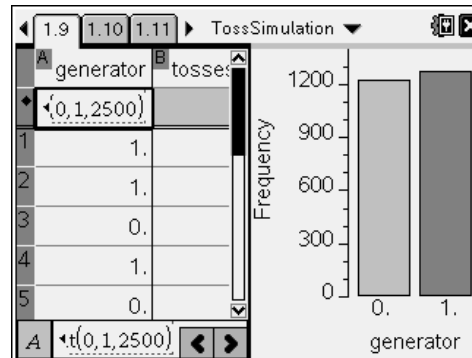


Students will also need to change the window as the number of trials increases. This is done by choosing **MENU > Window/Zoom > Zoom Data** when they are in the graph application. By clicking on the “0” bar, students will get the exact number of heads.



Students will continue to change **randInt** command in Column A for the different number of trials until they have gathered all the data. Each time they change the number or trials they will get a message asking if they would like to overwrite the data. Always choose OK.

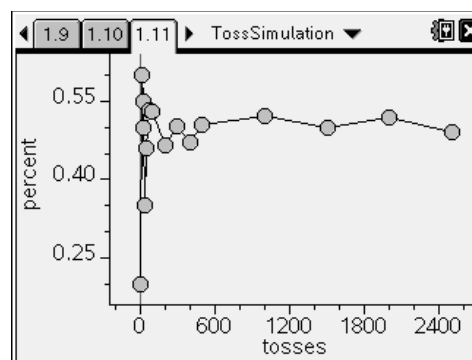
Note: Since students are using a random number generator, they will get different results.



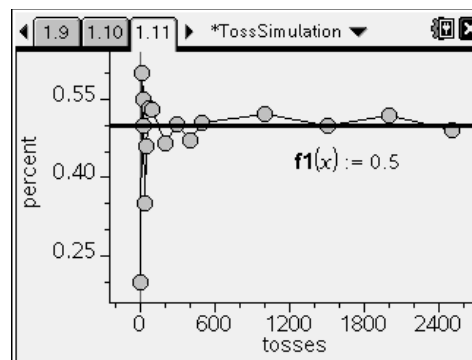
The percent of heads tossed has been automatically calculated for the students in Column D. Explain to students that it is the number of heads divided by the number of trials.

After all the data is collected, students will then use the data to create a scatter plot of the percent of heads versus the number of trials.

Instruct students to connect the data points (**MENU > Plot Properties > Connect Data Points**).



For students better see that the experimental probability approaches the theoretical probability, have them add a horizontal line at 0.5. To do this, press **MENU > Analyze > Plot Function** and then type 0.5 in the box that appears.



### Discussion Points:

- What is the theoretical probability of obtaining a head when tossing a coin?
- What happens to the percent of heads as the number of trials increases?
- This is called The Law of Large Numbers. It says that as the number of trials increases, the experimental probability of an event will approach the theoretical probability.

## Problem 2 – Rolling a die

This problem can be done in pairs during class or as a homework problem.

Students will simulate the rolling of a six-sided die. Instruct students to conduct the simulation using the same method as outlined in Problem 1.

Explain to students that the command `randInt(1,6)` returns an integer between 1 and 6. So when it was `randInt(0,1)` there are only two possibilities because there are no other integers between 0 and 1.

Notes:

When creating the bar graph, students will need to change the data to categorical data (**MENU > Plot Properties > Force Categorical x**). They will also need to change it from a dot plot to a bar graph (**MENU > Plot Type > Bar Chart**).

When creating the spreadsheet, students will need to enter the formula to generate the data and find the percents.

Having students plot the theoretical probability  $\frac{1}{6}$  on the scatter plot will reinforce the concept of the activity.

## Extension – Rolling two dice and recording a sum

This problem can be done in pairs during class or as a homework problem.

Challenge students to simulate the rolling of two dice and finding the sum. Record the number of sums that are 7. They will be tempted to use integers from 2–12. However, this does not take into consideration that each sum does not have an equal probability of being chosen.

Students are to use `randInt(1,6, number of trials)` in two columns to generate the rolls of die1 and die2. They will need an additional column to sum the dice.

The solution TI-Nspire document has the solution to the problem.

Having students plot the theoretical probability  $\frac{1}{6}$  on the scatter plot will reinforce the concept of the activity.

