

Plinko!

ID: 12731

Time required

45 minutes

Activity Overview

In this activity, students will simulate a popular game, find experimental probabilities, and then compare those probabilities to the corresponding theoretical probabilities.

Topic: Numbers and Operations

- *Understand and apply basic concepts of probability*
- *Compute probabilities for simple compound events, using such methods as organized lists, tree diagrams, and area models*

Teacher Preparation and Notes

- *TI-Navigator is not required for this activity, but an extension is given for those teachers that would like to use it.*
- **To download the student worksheet and TI-Navigator files, go to education.ti.com/exchange and enter “12731” in the quick search box.**

Associated Materials

- *MGAct28_Plinko_worksheet_TI73.doc*
- *MGAct28_Plinko_Nav_TI73.act*

Suggested Related Activities

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

- *Surround and be Found! Triangular Areas, That Is! (TI-73 Explorer) — 4651*
- *Area Formulas App (TI-73 Explorer) — 6814*

Problem 1 – Simulate the Game

In this problem, students will simulate playing the Plinko game. This game involves dropping a disk from the top of a game board. It then bounces either left or right off pins as it moves down the board where it ultimately falls into one of five numbered slots. They will then calculate the experimental probabilities of the simulation before finding the theoretical probabilities.

Questions 1–6

Engage students in a discussion about the possible outcomes and see what they think will happen.

To set up the random number generator to have unique starting values, have students enter a unique value (some digits of student ID#, last 4 digits of their home phone number, etc.) and store this to the random seed.

On the Home screen, enter the number and press **STO►**

MATH ► ► **ENTER** **ENTER**.

Then, to generate a random 4-digit number, press **MATH**

► ► ▾ **ENTER**. Enter 1000, 9999 and press **▸** **ENTER** to

execute the command. This will generate a random number between 1000 and 9999.

Students should decide if an even number represents a left or right movement. Then an odd number indicates the opposite. The outcome of the simulation is not affected by this decision.

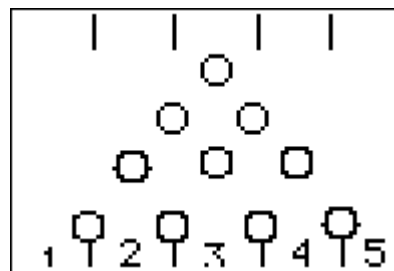
Students should execute the random command 9 additional times to have a total of 10 trials. They will need to keep track of each slot that the disk lands in.

Questions 7–8

Once students have collected 10 trials, they will need to enter the data in **L1** and **L2**. To access the List Editor, press **LIST**. If **L1** or **L2** have data in them, students can quickly clear them by moving the cursor to the top of the list and pressing **CLEAR** **ENTER**. Students should enter 1 – 5 in **L1** and then their collected values in **L2**.

Next, students should set up a stat plot as shown at the right. Press **2nd** **Y=** **ENTER** to access **Plot1**. Then press **ZOOM** **7** to display the graph.

After students have explored their individual graphs, enter all data into one calculator and create a histogram of the classes' data. This can either be done on the teacher calculator or lists can be sent to all students. Have students discuss the differences between their small sample of data and the larger class set of data.



```
3158→rand 3158
randInt(1000,999
9)
5328
```

L1	L2	L3	?
1	1		
2	3		
3	4		
4	1		
5	1		
-----	-----		
L3(1) =			

```
Plot1  Off
Type:     
   
Xlist:L1
Freq:L2
```

Question 9

After students discuss the class set of data, they will calculate the experimental probability of each number occurring.

Problem 2 – Theoretical Probability

Questions 10–12

Now students will look at the theoretical probability of each outcome. First, they identify all the possible combinations of 4-digit number and their correlated left/right movements.

Students should relate the left/right movements to the slot in which the disk lands.

Question 13

Next, students will take the possible outcomes and calculate the theoretical probability of each outcome. Slot 1, for example, has a 1 in 16 chance of happening. (16 possible outcomes, and 1 LLLL possibility)

1/16	.0625
4/16	.25
6/16	.375

Questions 14–15

The last two questions are intended to help students realize that the larger the set of data, the closer the experimental probability will be to the theoretical probability. There may be students in the class that have individual sets of data that are rather close to the theoretical probability just by coincidence but others may vary much more.

Extensions

This activity can be extended several different ways. For example, in 16 trials the disk should theoretically land in the slots, from left to right, 1, 4, 6, 4, and 1 times. This sequence of numbers can be found in the 5th row of Pascal's triangle. Using this observation, students can determine the probabilities for Plinko games with additional slots and rows of pins. A connection to the binomial theorem can also be made for advanced students.

Extension – TI-Navigator™

- To begin the lesson, load the activity settings file *MGAct28_Plinko_Nav_T173.act* into Activity center. Start the activity when students are ready to submit their individual 10 data points (after Question 7). After all data points have been received from the students, stop the activity, click on **Configure** and click the button for “**Existing Activity List**”. This will send the class set of data back to all students.
- Use **Quick Poll** to capture student input for the possible combinations in Question 10. **Quick Poll** can be used at many other times throughout the activity to gather student thoughts and opinions. This will help the class see what others are thinking as well.

Solutions – student worksheet
Problem 1

1. Answers will vary. Students should be able to support thoughts with reason
2. Students should set up random number generator.
3. Students can choose even to be either left or right and odd then becomes the other direction.
4. Answers will vary. Directional movements should represent the decision in Question 3 of odd / even movements.
5. Answers will vary. Should be consistent with Questions 3 and 4.
6. Student data will vary.
7. Graphs will vary. Graph should accurately reflect data from Question 6. Data should be normally distributed about Slot 3.
8. The class graph should be the same among students. Ensure students have accurately labeled axes and bars as instructed.
9. Experimental probability will vary depending on class data.

Problem 2

10. LLLL, LLLR, LLRL, LLRR,
LRLl, LRLR, LRRL, LRRR,
RLLL, RLLR, RLRL, RLRR,
RRLl, RRLR, RRRL, RRRR

11. 16

12.

Movements	Slot
4 Lefts	1
3 Lefts, 1 Right	2
2 Lefts, 2 Rights	3
1 Left, 3 Rights	4
4 Rights	5

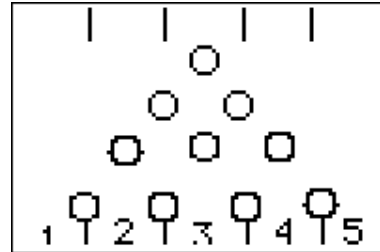
13. Slot 1: $\frac{1}{16}$; Slot 2: $\frac{4}{16}$; Slot 3: $\frac{6}{16}$; Slot 4: $\frac{4}{16}$; Slot 5: $\frac{1}{16}$;
14. Answers will vary based on actual student data.
15. Answers will vary based on actual class data.

Problem 1 – Simulate the Game

In the game Plinko, a disk is dropped from the top of a game board. It bounces either left or right off pins as it moves down the board where it lands in 1 of 5 numbered slots.

- Suppose the disk is dropped from the middle slot each time and the disk has an equal probability of bouncing left or right each time.

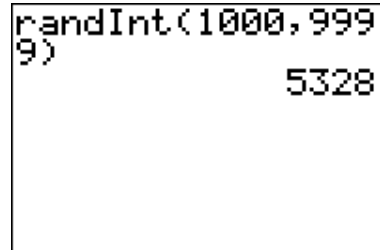
What do you think the distribution of results will be in 10 trials?



- Set up the random number generator. Enter a unique number instructed by your teacher on the Home screen. Then press **STO** **MATH** **▶** **▶** **ENTER** **ENTER**.

- Next, generate a 4-digit random number that determines the direction the disk bounces on each row. Decide if an odd number means a left or right bounce. Then an even number means the opposite.

Odd = _____ bounce Even = _____ bounce



- Describe the direction of movements of the disk for the number in Question 3.

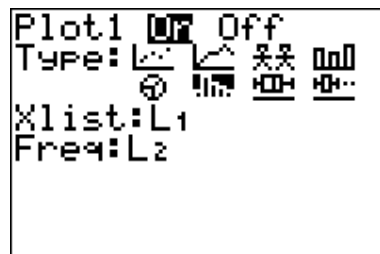
- Which slot did the disk land in? _____

- Run nine more trials and keep track of the slot each disk lands in. _____

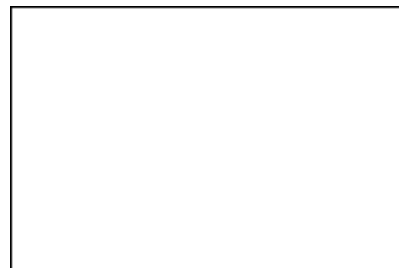
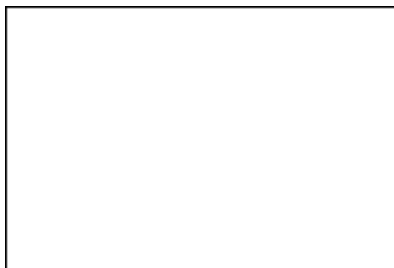
- Enter the slot number in **L1**. Enter the number of times the disk landed in each slot in **L2**.

Create a histogram. Press **2nd** **Y=** and select **Plot1**. Change the settings to those shown at the right.

Press **ZOOM** and select **ZoomStat**.



- Draw your histogram (of 10 trials) and a histogram of the class data below.



9. On the Home screen, calculate the experimental probability of the disk landing in each number slot for the class.

Slot 1: _____ Slot 2: _____ Slot 3: _____ Slot 4: _____ Slot 5: _____

Problem 2 – Theoretical Probability

Now you will determine the theoretical probability of the disk landing in each slot.

10. What are all the possible combinations of bounces for the disk? For example, it could go LLLL or LRLR. Find the other combinations.

11. How many total combinations exist? _____

12. Given the possible movements of the disk from Question 10, complete the following table.

Movements	Slot
4 Lefts	1
___ Lefts, ___ Rights	
___ Lefts, ___ Rights	
___ Lefts, ___ Rights	
4 Rights	5

13. Now, calculate the theoretical probabilities of the disk landing in each slot.

Slot 1: _____ Slot 2: _____ Slot 3: _____ Slot 4: _____ Slot 5: _____

14. How do the results from your 10 trials (Questions 5 & 6) compare to the theoretical probabilities?

15. How do the results of the class data (Question 8, graph 2) compare to the theoretical probabilities?
