

AVERAGES WITH DICE

Teacher Notes

References

Foundation	D1.4: Calculating probabilities.	D4.1, D4.2: Averages and Range.
Foundation Plus	D1.5: Expected frequency.	D4.1, D4.2: Averages and Range.
Higher	D3.3: Probability and expectation.	D1.4: Averages and Spread.
Higher Plus	D3.2: Expected frequency.	D1.3: Averages and Spread.

Introduction

Students use their TI-Nspires to simulate the throws of one or more dice, and to tabulate outcomes. They can then plot the data and obtain the three types of average and the range.

Resources

There is a 3-page handout that guides students through the activity, starting with a new blank TI-Nspire document.

No ready-made TI-Nspire documents are needed for this activity.

TI-Nspire skills students will need

Opening pages of a new document on the handheld.
Moving from one page to another in a document.

The activity

This activity is designed for use by students working individually on TI-Nspire handhelds, but it can also be demonstrated on a screen using the TI-Nspire Navigator System, which makes it easy to compare and discuss students' different results.

There are four sections in the student notes, which give detailed instructions including the key presses that are needed. Below are comments relating to each section and possible extension activities.

Section 1. Roll some dice

a) The command `randint(1,6)` produces random integers from 1 to 6. Note this is discrete, not continuous, data. It is important to realise that it is possible (though unlikely) that some students will have unexpected results such as rolling six sixes in a row—such is the nature of randomness!

However, because the TI-Nspire is a digital device, it actually only calculates pseudo-random numbers. It uses a powerful algorithm, based upon its previously chosen random number. This means that every handheld leaving the factory would produce the same sequence of random numbers if given exactly the same commands. Consequently, if your class set of handhelds has not been used to generate random numbers previously, every student could see the same sequence of dice throws appearing. This can be avoided by typing on the calculator page **randseed** followed by any individually chosen integer e.g. **randseed 2143**.

b) The command `randint(1,6,18)` produces 18 dice throws in a list. The most likely number of sixes from eighteen throws is 3, i.e. the expected frequency is 3 sixes.

c) Students define a new command **dice(x)** that can subsequently be used instead of **randint(1,6,x)**. So **dice(x)** can be used to simulate x throws of a die or alternatively, as in sections 3 and 4, to simulate the throws of x dice.

Section 2. How long to throw a six?

a) Notice the change of question here. No longer is the emphasis on *how many sixes* occur, but rather on *how many throws until a six* occurs.

Students are asked to predict the number of necessary throws and then simulate a long sequence of throws using **dice(50)**. They need to count how many have been needed to produce the first six. The choice of a sequence of 50 was arbitrary—there is of course a very small possibility that `dice(50)` will not produce any sixes! At this stage students will need to write down the number of throws needed each time

b) Students add a Lists & Spreadsheets page and add their recorded data, labelling it **throws**. “How many times do you think you need to do this?”—as many as possible in the time available. A minimum of 25 items of data is recommended.

c) Adding a Data & Statistics page allows the data to be displayed graphically. A dot plot is the default type of plot and (arguably) better than a bar chart for this type of discrete data. It is possible to add extra data to the spreadsheet and new dots will appear automatically on the dot plot, with the vertical scale being adjusted if necessary. The dot plot quickly shows the range of the data as well as the mode.

d) Using option 2 from the Plot Type menu changes the dot plot to a box plot. This enables students easily to find the median. The default boxplot type shows outliers, as shown in the screenshot. If you wish, this can be changed to extended box-plot whiskers using option 3 from the Plot Properties menu.

Notice that whereas the median and mode can be found directly from statistical plots, there is no similar way of finding the mean—there is a greater level of abstraction inherent in this type of average. Students need to return to the Calculator page and enter **mean(throws)**.

Section 3: Throwing two dice

a) In this section students use the handheld to calculate the totals of two dice and are shown how to quickly store these totals in a spreadsheet. Note that if you subsequently create a new list of totals the old values in column A all disappear.

b) Students create increasingly longer lists of totals and are able to see how the range and averages change as more data are used.

Section 4: Triple odds

a) The probability of rolling triple odds is $1/8$, so the most likely number of rolls is 8.

b) As in section 2, students need to count the number of rolls and manually enter the data into the spreadsheet—there is no possibility of quicker data entry in this case. By now they should be used to adding the necessary pages to their TI-Nspire document and to finding the three types of averages.

Possible extensions

Students can be encouraged to analyse other dice games using their handheld. There is a lengthy list of such games under Dice Games on Wikipedia or students can make up their own.

Alternatively the command `randInt` may be used to simulate other randomly occurring events where the resulting data lends itself to analysis in similar ways. For example, `randInt(0,1)` can be used to simulate the toss of a coin, so `sum(randInt(0,1,100))` could represent the number of heads that occur when 100 coins are tossed.