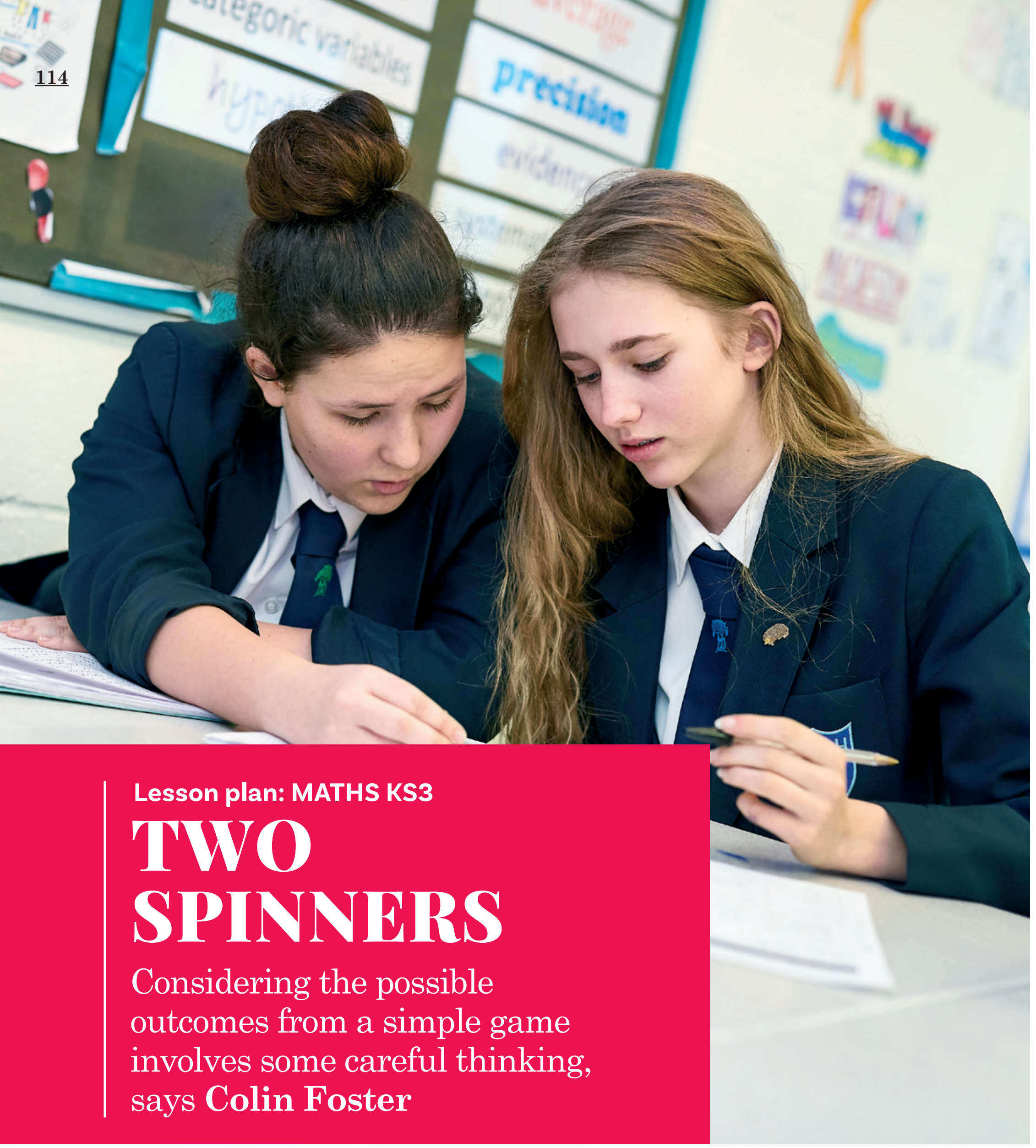


Lesson plan: MATHS KS3

# TWO SPINNERS

Considering the possible outcomes from a simple game involves some careful thinking, says **Colin Foster**

Download another KS3 lesson on probability, for FREE, at **teachwire.net/moreprobability**

**WHY TEACH THIS?**

Many real-world situations involve probability, but students' intuitions can often be wrong.

**KEY CURRICULUM LINKS**

+ Generate theoretical sample spaces for single and combined events with equally likely, mutually exclusive outcomes and use these to calculate theoretical probabilities.

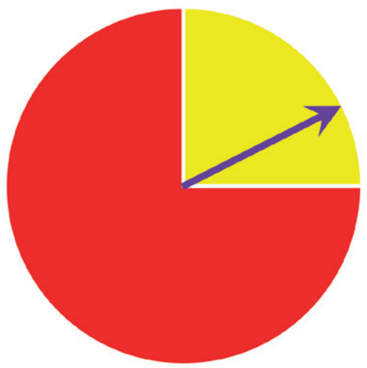
**KEY QUESTION**

How can we predict the probabilities of the outcomes from two spinners?

In this lesson, students have to find the possible total scores when spinning two different spinners. Spinners are quick and easy to create in the classroom, and students can experiment to test out their conjectures. Constructing a sample space diagram allows students to predict and explain the outcomes and calculate theoretical probabilities.

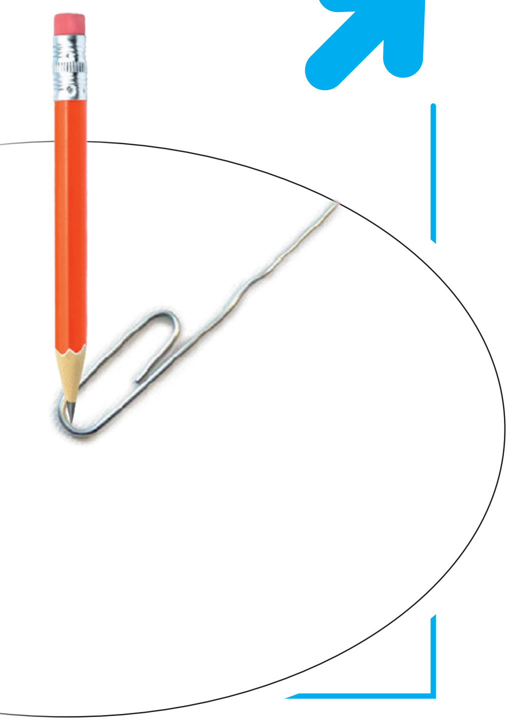
## STARTER ACTIVITY

**Q** *Look at this spinner. I am going to spin it 4 times. I win if the arrow lands on the colour that I pick. How many times should I pick red and how many times should I pick yellow? Why?*



Make sure that students understand the idea of a spinner. The easiest way to create one in the classroom is to draw a circle on a piece of paper and then use a pen or pencil to hold an opened-out paperclip at the centre, with its arm pointing to the circumference of the circle. To set the spinner going, you flick the paperclip with your finger.

Students may see quite quickly that the probability of landing on red is greater than the probability of landing on yellow, and even that p(red) = ¾ and p(yellow) = ¼. However, students frequently say that they would choose red 3 times and yellow once, and this is *not* optimal. In fact, since red is more likely than yellow ***every time***, they should choose red ***every time***. Yellow is never more likely than red. This would still be the best strategy even if the red sector were only a very tiny bit larger than the yellow sector. Students may find this counterintuitive.

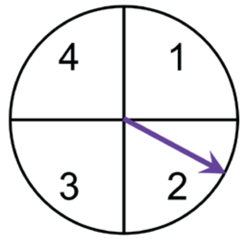


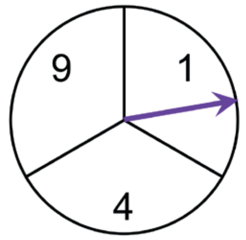




## MAIN ACTIVITIES

**Q This time we have two spinners, one with 4 equal sectors, and the other with 3 equal sectors. We are going to spin them at the same time and add up the numbers that we get. What totals might you obtain? Are they equally likely? Why?**




Students will realise that they can't get a total of 1, because the lowest total will come from getting a 1 on each spinner, which gives a total of 2. The largest total will arise from getting a 4 on the first spinner and a 9 on the second, giving a total of 13. (Note that this doesn't mean that all integers between 2 and 13 are possible!)

**Q Work out the probability of getting each possible total.**

Being systematic and making a two-way table sample space of possibilities is a great help.

| | | Spinner 1 | | | |
|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** |
| Spinner 2 | **1** | 2 | 3 | 4 | 5 |
| | **4** | 5 | 6 | 7 | 8 |
| | **9** | 10 | 11 | 12 | 13 |

The surprise for students will be that a total of 9 is impossible, and that 5 is twice as likely as all of the other possible outcomes, because it can be made in two different ways (1 + 4 and 4 + 1), as shown in the table below.

| Sum | Number of ways | Probability |
|---|---|---|
| 1 | 0 | 0 |
| 2 | 1 | 1/12 |
| 3 | 1 | 1/12 |
| 4 | 1 | 1/12 |
| 5 | 2 | 1/6 |
| 6 | 1 | 1/12 |
| 7 | 1 | 1/12 |
| 8 | 1 | 1/12 |
| 9 | 0 | 0 |
| 10 | 1 | 1/12 |
| 11 | 1 | 1/12 |
| 12 | 1 | 1/12 |
| 13 | 1 | 1/12 |
| **Total** | **12** | **1** |

If some students doubt that 5 really is twice as likely as the other possible outcomes (they may think that, because of commutativity, 1 + 4 and 4 + 1 are 'the same thing'), then they can draw out the spinners and use a paperclip pointer to try it out.

**Q Now change the numbers on the sectors of the two spinners (keep the number of sectors the same for now, so it's still a 4-sector spinner and a 3-sector spinner). What possible sums can you get? Can you make all of the outcomes equally probable? What interesting sets of outcomes can you create? Can you make one where only prime numbers are possible, for example?**

This is a very open task. It will generate plenty of practice at creating sample space diagrams, but with a bigger aim of producing an interesting set of possibilities.

## DISCUSSION

You could conclude the lesson by discussing how students worked on the problem and what they created.

**Q.** *What did you try? What spinners did you design and what are their outcomes? How do you know? Did anything surprise you?*

Students could check each other's creations to see whether they agree about the possible outcomes and their probabilities.

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**NEXT STEPS**

A related problem is available at **nrich.maths.org/7541**

**GOING DEEPER**

Students could look at the **absolute difference** (defined as the higher number – the lower number) instead of the sum, and see what the probabilities are. Adventurous students could also consider using three spinners rather than two.

**THE AUTHOR**

Colin Foster is an Associate Professor in the School of Education at the University of Leicester. He has written many books and articles for mathematics teachers (see **www.foster77.co.uk** and **@colinfoster77** on Twitter).