

	Penalty Shoot-Out	<i>Lesson Plan</i>
<p><i>Activity</i></p> <p>1</p>	<p>Introduction</p> <p>T: What happens in the knock out phase of the World Cup if the two sides are drawing after 90 minutes? <i>(They play 30 minutes extra time)</i></p> <p>T: What happens if they are still drawing after extra time? <i>(They have a penalty shoot-out)</i></p> <p>T: Who can explain the rules?</p> <p>T: What strategies can team use to maximise their chances of winning the penalty shoot-out? Should the best penalty takers shoot first?</p>	<p><i>Notes</i></p> <p>T: Teacher P: Pupil</p> <p>Use Ps' knowledge and experience here to guide the discussion.</p> <p>Show OS1 if class are not clear on the rules (they might be familiar with the rules at the end of 'The Weakest Link' which are essentially the same).</p> <p>Discuss strategies with class.</p>
<p>2</p>	<p>Simulation</p> <p>T: We can simulate penalty shoot-outs by using random numbers and deciding the probability of scoring a goal.</p> <p>T: What are random numbers? Practical examples? <i>(Any number has equal chance of being chosen)</i> <i>(National Lottery)</i></p> <p>T: Here is a sheet of random numbers. How could you check that they are random? <i>(Check total number of each digit)</i> <i>(Check pairs of numbers as well)</i></p> <p>T: How long can the penalty shoot-out last? <i>(It could go on for ever!)</i></p> <p>T: We will use the simulation to see the average number of kicks taken and the most likely result; we are going to assume that each penalty taker has a 0.6 chance of scoring. How can we use the random numbers to model this? <i>(Use the digits 0, 1, 2, 3, 4 and 5 for success – penalty scored; and digits 6, 7, 8 and 9 for failure – penalty miss)</i></p> <p>T: How can we choose two digits to represent the situation? <i>(Take the first two digits in each column)</i></p> <p>T: So what do we get? <i>(31 – which means Score Score – we can write as 4 4)</i></p> <p>T: What are next results? <i>(97 – 5 5, 72 – 5 4 , 69 – 5 5, 62 – 5 4)</i></p> <p>T: So we have a winner by 1-3.</p> <p>We can use a chart approach to record the result.</p>	<p>You might need to explain in more detail what is meant by 'simulation'.</p> <p>Give out copies of OS2.</p> <p>For those unfamiliar with simulations, you will need to approach this carefully.</p> <p>Try to get Ps to find an appropriate rule here.</p> <p>31 97 72 69 62 40 07 26 36 18 </p> <p>Give out copies of OS3.</p>

Penalty Shoot-Out

	<table border="1"> <thead> <tr> <th>Team A</th> <th>Team B</th> </tr> </thead> <tbody> <tr> <td>4</td> <td>4</td> </tr> <tr> <td>5</td> <td>5</td> </tr> <tr> <td>5</td> <td>4</td> </tr> <tr> <td>5</td> <td>4</td> </tr> <tr> <td></td> <td></td> </tr> </tbody> </table> <p>T: Continue in this way, working in pairs, and simulate the shoot-out 20 times in total.</p> <p>T: Calculate the <i>average</i> number of kicks per shoot-out and find the <i>modal</i> result.</p> <p>T: How many times did it go to the knock-out stage?</p>	Team A	Team B	4	4	5	5	5	4	5	4													<p>T monitors process, ensuring that all pairs are making progress.</p> <p>If class is capable, suggest using different starting points in the table (or their calculators) for the random numbers.</p> <p>This gives more powerful final results for the whole class.</p> <p>It will be about 9, and 4-3 / 3-4 likely to be the modal result.</p> <p>Discussion of results, and how the simulation could be improved.</p>
Team A	Team B																							
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<p>3</p>	<p>Extension</p> <p>There are two possible extensions:</p> <p>A: assign different probabilities to each team;</p> <p>B: assign different probabilities to each team member.</p> <p>Another task would be to write a computer program or use a spreadsheet to simulate this.</p>	<p>Discussion might include reference to the Switzerland versus Ukraine match in which Switzerland failed to score with all 3 of its penalty kicks.</p> <p>See the Interactive version of this activity.</p>																						