

Maths Session: Equal or unequal?

Age range: 9–14 years

<p>Outline</p> <p>Learners will use fractions and the language of probability to describe the chances of different teams winning the 2022 World Cup. They will then discuss possible reasons why some teams are more likely to win than others, linking this not only to football but also to wider issues related to the resources available to a country. Next, learners will investigate whether the World Cup teams come from generally higher or lower-income countries. They will use fractions and percentages to compare the wealth (or income) of the World Cup countries, before using ratios to express these between-country income inequalities. In the final activity, learners will use “fairness scores” (GINI indices) to investigate how fair or equal individual countries playing in the World Cup are. Learners will compare and order the scores for different countries, before calculating the mean or average score. They will use their findings to consider whether the World Cup countries are generally equal or not.</p>	
<p>Learning objectives</p> <ul style="list-style-type: none"> • To apply knowledge of fractions and probability to describe the chances of different teams winning the 2022 World Cup. • To use fractions, percentages and ratios to compare the income of different countries. • To interpret real-life data and use this to draw conclusions. • To calculate the mean of a set of numbers. • To develop discussion and critical thinking skills. 	<p>Learning outcomes</p> <ul style="list-style-type: none"> • Learners will use fractions, the language of probability and FIFA rankings to assess the chances of different teams winning the 2022 World Cup. • Learners will think critically about possible football and non-football reasons that might affect a team’s chances of success. • Learners will use tallies, fractions, percentages and ratios to compare inequality data from the countries taking part in the 2022 World Cup. • Learners will discuss what global inequality means and the possible implications of this for people living in “poorer” or “richer” countries.
<p>Key questions</p> <ul style="list-style-type: none"> • Do all teams have an equal chance of winning the World Cup? Why? / Why not? Is this fair? • How wealthy are the countries taking part in the 2022 World Cup? • How equal or unequal are people living within these countries? • Which countries are more equal? • Which countries are more unequal? 	<p>Resources</p> <ul style="list-style-type: none"> • <i>The World Cup: A Fair Game?</i> Maths slideshow • Resource sheets: <ol style="list-style-type: none"> 1. <i>FIFA rankings</i> 2. <i>World Cup statistics table (also provided as a separate MS Excel spreadsheet)</i> 3. <i>World Cup inequality ratios – completed table</i> • Activity sheets: <ol style="list-style-type: none"> 1. <i>World Cup country incomes</i> 2. <i>World Cup inequality ratios</i> 3. <i>Fairness scores – comparing teams</i> 4. <i>Fairness scores – comparing groups</i>

Curriculum links		
<p>England <i>Pupils should be taught to:</i></p> <p>KS2 Mathematics Number – fractions (including decimals and percentages)</p> <ul style="list-style-type: none"> • Compare and order fractions. • Recall and use equivalences between simple fractions, decimals and percentages, including in different contexts. <p>Ratio and proportion</p> <ul style="list-style-type: none"> • Solve problems involving the relative sizes of two quantities. <p>Statistics</p> <ul style="list-style-type: none"> • Complete, read and interpret information in tables. • Calculate and interpret the mean as an average. <p>KS3 Mathematics Number</p> <ul style="list-style-type: none"> • Interpret fractions and percentages as operators. <p>Probability</p> <ul style="list-style-type: none"> • Record, describe and analyse the frequency of outcomes of simple probability experiments involving randomness, fairness, equally and unequally likely outcomes, using appropriate language and the 0-1 probability scale. <p>Statistics</p> <ul style="list-style-type: none"> • Describe, interpret and compare observed distributions of a single variable through appropriate measures of central tendency (mean, mode, median). • Construct and interpret appropriate tables, charts, and diagrams, including bar charts, for ungrouped and grouped numerical data. 	<p>Wales KS2 Mathematic Fractions, decimals, percentages and ratio</p> <ul style="list-style-type: none"> • Use understanding of simple fraction, decimal and percentage equivalences. • Use simple ratio and proportion. <p>Collect and record data, present and analyse data, interpret results</p> <ul style="list-style-type: none"> • Extract and interpret information from an increasing range of diagrams, timetables and graphs (including pie charts). • Use mean, median, mode and range to describe a data set. <p>Probability</p> <ul style="list-style-type: none"> • Use numbers to describe the likelihood of an event, for example, a one-in-six chance. • Identify the outcomes of simple events, for example, flipping a coin, rolling a dice. <p>KS3 Mathematics Fractions, decimals, percentages and ratio</p> <ul style="list-style-type: none"> • Use, interpret and calculate with different representations of fractions. <p>Collect and record data, present and analyse data, interpret results</p> <ul style="list-style-type: none"> • Construct and interpret graphs and diagrams (including pie charts) to represent discrete or continuous data, with the learner choosing an appropriate scale. • Find the mean, median, mode and range from grouped frequency tables and explain why it is an estimate. <p>Probability</p> <ul style="list-style-type: none"> • Use the sum of all probabilities is 1 – simple cases, for example, rolling a dice P (not 6). • Recognise that practice is different from theory and that repeated experiments may give different results. 	<p>Scotland Numeracy and mathematics Number, money and measure - Fractions, decimal fractions and percentages including ratio and proportion</p> <ul style="list-style-type: none"> • I can solve problems by carrying out calculations with a wide range of fractions, decimal fractions and percentages, using my answers to make comparisons and informed choices for real-life situations. MNU 2-07a and 3-07a <p>Information handling - Data and analysis</p> <ul style="list-style-type: none"> • I can work collaboratively, making appropriate use of technology, to source information presented in a range of ways, interpret what it conveys and discuss whether I believe the information to be robust, vague or misleading. MNU 2-20a and 3-20a • I have carried out investigations and surveys, devising and using a variety of methods to gather information and have worked with others to collate, organise and communicate the results in an appropriate way. MNU 2-20b • When analysing information or collecting data of my own, I can use my understanding of how bias may arise and how sample size can affect precision, to ensure that the data allows for fair conclusions to be drawn. MTH 3-20b <p>Ideas of chance and uncertainty</p> <ul style="list-style-type: none"> • I can find the probability of a simple event happening and explain why the consequences of the event, as well as its probability, should be considered when making choices. MNU 2-22a and 3-22a

Activity 1 (30 min+)

What are the chances of winning?

- Introduce the activity by explaining that learners will be considering how “fair” the World Cup is. *Although the rules of football are the same for everyone, does every team have an equal chance of taking part and winning?* They will be using probability to examine this, before considering possible reasons that might affect a team’s chances of success.
- Use the three true/false statements on slide 3 of the Maths slideshow to introduce the idea of probability, expressed as statements or fractions, in relation to the World Cup. Learners may know or be able to guess whether the statements are true or false but explain that they will find out the correct answers later in the activity.
- Explain that 32 countries from around the world will be taking part in the World Cup. Show slide 4 and say that these are the flags of the countries taking part. These countries are marked in blue on the world map (see the slide notes for further details). Ask learners which flags they can identify. *Where are these countries on the map?* *Note: Details of which countries these flags belong to are provided in slide 6.*
- Now, ask learners if they can work out, as fractions of an amount, how likely each country is to win ($1/32$).
- Now, using the same concept, ask learners to answer the probability questions on slide 5. Discuss their answers and how they calculated these. *If every team has a $1/32$ chance of winning, does this mean every team has an equal chance of winning? What else might affect a team’s chances of success?* Encourage learners to consider reasons such as whether countries have won before, the players in the teams and the resources that different countries have. *Note: Learners will discuss this question in greater depth later in this activity and elsewhere in the session.*
- Show slide 6 and explain that FIFA gives each team in the World Cup a ranking based its level of success in matches. *Note: FIFA calculates these rankings by looking at a team’s total number of points over the last four years; teams can win points from the matches that they play with other countries. The more successful a team is, the more points it gains and the higher its ranking. For more information on the ranking procedure, see: <https://www.fifa.com/procedure-men>*
- Point out that these rankings suggest that the chances of success are not equal among the countries. Explain that learners are now going to use these FIFA rankings to make “probability statements” to describe how likely individual countries/groups, or teams from different continents are of winning the World Cup.
- Use slide 7 to demonstrate how to make probability statements for different countries, groups and continents with words and phrases such as “more likely” or “less likely”, using the FIFA rankings as evidence.
- Allow time for learners to make their own probability statements. This could be done either individually or in pairs. The FIFA ranking data on slide 6 is also provided in *FIFA rankings* (Resource sheet 1).
- Invite learners to share their statements and discuss these as a class.
- Ask the question again: *Does every team have an equal chance of winning?* Encourage learners to consider not just individual teams, but also teams from different continents, for example Europe or Africa.

- *Note: There are more European teams in the World Cup as FIFA allocates them more places – this makes it statistically more likely that a team from Europe will win the World Cup than one from another continent. However, the FIFA rankings also show that teams from Europe have higher rankings than teams from Africa and Asia. This means that it is more likely that a team from Europe will win, both because there are more teams from Europe and because of these teams having higher FIFA rankings. As an extension activity, learners could calculate the average rankings of teams per continent.*
- Draw out that the FIFA rankings show that certain countries, or teams from certain continents, have a better chance of winning than others. Ask learners why they think this might be.
- Use slides 8 and 9 to help learners to think about possible reasons related to football (such as having star players or a good manager) and reasons not directly connected with football (such as better education and healthcare or greater government investment in sports). Use the question “why” repeatedly to help develop learners’ thinking.
- Discuss whether learners think these differences are fair. Explain that they will be considering this question in more detail in the next activity.

Differentiation

- *Make it easier: Learners could just focus on two or three of the probability questions on slide 5. Alternatively, learners could work in pairs or threes to construct probability statements for different countries and groups, and then combine their answers with other pairs or threes.*
- *Make it harder: Learners could express the probabilities as percentages and decimals as well as fractions.*

Activity 2 (60 min)

Comparing income

- Remind learners that in the last activity they started to consider why teams in the World Cup don’t have an equal chance of winning. Explain that in this activity they will investigate whether the income (or wealth) of a country affects its chances of winning.
- Explain that there are huge differences between the incomes of countries. An organisation called the World Bank pays close attention to this. It lends money to different countries and calculates countries’ “income”, which it works out as an average per person, to be able to compare countries with more or fewer people. To calculate it they add up the total amount of money being made in that country over the year. They then divide this by the number of people in the country. They do this calculation in US dollars so they can compare all countries fairly. The World Bank then sorts countries into different groups depending on their income: low, lower-middle, upper-middle and high.
- Show slide 10 and ask learners which income group they think each of the countries shown is in. Discuss learners’ ideas and their reasons for them. Click on the slide to reveal the correct answers and discuss learners’ responses. *Are they surprised by any of the answers? Which ones and why? Note: The average annual income per person for each of these countries is provided in the slide notes.*
- Now show slide 11 and explain that these are the 32 average incomes (per person per year) from the countries in the World Cup. *Are you surprised by this data? If so, why? Which income do you think belongs to which country?* Possible questions are provided in the slide notes.



- Show slide 12 and introduce the word “inequality” as the difference between the resources or opportunities available for one group of people versus another.
- Show slide 13 and explain that this world map shows average annual income per person in different countries across the world. Countries with a lower average income are shaded in orange and yellow; those with a higher average income are shaded in green. Discuss learners’ responses to this map. *What do you notice? Where are most of the richer countries? Note: It is not essential for learners to be able to read the country names on the map.*
- You may wish to point out that countries towards the Northern hemisphere are often called “developed” countries, and countries towards the Southern hemisphere are often called “developing” countries.
- Organise learners into pairs and give each pair copies of *World Cup statistics table* (Resource sheet 2) and *World Cup country incomes* (Activity sheet 1). Ask learners to use the data in the table to make a tally of the number of World Cup countries in each income group. *How many countries are in each income group? Note: The data is also provided in the World Cup statistics MS Excel spreadsheet, provided as a separate download.*
- Now ask learners to express the number of countries in each group as a fraction (out of the combined total of 32 World Cup countries) and then as a percentage (1/8 and 12.5%).
- Discuss learners’ responses to the results. *What do they notice? Are the World Cup countries generally wealthy or poorer?* Draw out that the majority of World Cup countries are from the high-income or upper-middle-income groups. No country is classified as low-income.
- Lastly, can they work out how much more money the three “richest” countries in the World Cup have compared to the three “poorest”? They can use the table on *World Cup inequality ratios* (Activity sheet 2) to help them to calculate this ratio. *Note: A completed table is provided in Resource sheet 3.*
- Discuss learners’ responses to the fact that the three “richest” World Cup countries have more than **30 times** as much money per person as the three “poorest”. *Do they think that this inequality is fair? Why? / Why not?*
- Use slide 14 to prompt discussion about why teams from “poorer” countries may find it harder to compete. Ask learners to consider why income might be linked to success, both directly (for example by having wealthier teams and better facilities) and indirectly (for example by providing better schools and healthcare to support young players).
- Allow time at the end of the activity to discuss learners’ main findings. Use the sentence starters provided on slide 15 to support learners to make statements based on the evidence about these World Cup countries. Learners could record these on mini-whiteboards or paper and then discuss them with a partner or in small groups, before sharing their ideas with the rest of the class. Examples of possible statements include:
 - *Most of the high-income countries are in Europe.*
 - *A country is more likely to compete in the World Cup if it is in Europe.*
 - *The more money a country has, the more likely it is to take part in the World Cup.*
 - *Income inequality in the World Cup is very high.*
- Finish by discussing whether learners think it is fair that different countries have more or fewer resources than others, both to compete at football and in life more generally. *What do learners*



think is the impact on people as a result of the world being unequal in this way? Additional discussion questions are provided on slide 16.

Differentiation

- *Make it easier: Learners could just compare the tally totals rather than calculate fractions, percentages or ratios.*
- *Make it harder:*
 - *Learners could construct a bar or pie chart to represent the country income data.*
 - *Learners could collect, present and analyse income data for all the countries that have taken part in the World Cup since it began in 1930. For a list of the participating countries, see: en.wikipedia.org/wiki/National_team_appearances_in_the_FIFA_World_Cup*
 - *Learners could compare ratios of specific teams playing in different groups to find the largest income-inequality ratio per scheduled game.*
 - *Learners could research the average player's salary for players in the different World Cup teams and calculate inequality ratios for this as well.*

Activity 3 (60 min)

Fairness scores

Note: It would be useful if learners played the World Cup Trumps game (provided as a separate download) before carrying out this activity.

- Show slide 17 and remind learners that in the previous activity they explored differences in income or wealth between different countries participating in the World Cup. Now show slide 18 and explain that there is also often inequality within countries, meaning that some people in that country have only a little and others have a lot. Draw out the point that each country's average income per person is just that, an average, and there will be some people with higher incomes and some people with incomes that are lower.
- Show slide 19 and explain that this in-country inequality exists in many countries around the world, including the UK. For example, in 2014, the richest five families in the UK owned more wealth than the bottom 20 per cent of the population (12.6 million people). Discuss learners' responses to this statistic. *Do you think this inequality is fair?*
- Explain that there are different ways of measuring in-country inequality. One way is called the GINI index or ratio. We can think of this as a type of fairness score which shows how equal or unequal a country's people are.
- Show slide 20 and explain that a fairness score of 0 would mean that everyone in the country had exactly the same amount of money; there was no income inequality. In reality, no countries are like this. Discuss learners' thoughts about this possibility. *Would it be fair if everyone earned the same amount of money?* There might be reasons why some people should earn more. For example, some people will have more senior positions of responsibility in the workplace, or will want to work for less time because they want or need to spend time with their families or doing other things.
- Show slide 21 and explain that a fairness score of 100 would mean that the country was completely unequal. In reality, no country is like this either. Discuss learners' thoughts about this



possibility. *Do you think this is fair? Would you like to be considerably richer than everyone else? Would you like to be on the other side, with no money at all?*

- Explain that all countries are actually somewhere in the middle of 0 and 100. More equal countries are closer to 0 and more unequal countries are closer to 100. Show slide 22 and ask learners to plot the four examples on the scale. Click on the slide to display arrows showing the approximate locations of these countries on the scale. *Which of these countries is the fairest? (Belgium). Which are the most unequal? (Brazil and Costa Rica).*
- Organise learners into eight groups and give each group copies of the *World Cup statistics table* (Resource sheet 1) and *Fairness scores* (Activity sheets 3 and 4). *Note: The data is also provided in the World Cup statistics MS Excel spreadsheet, available as a separate download.*
- Allocate one World Cup group to each group of learners. Ask learners to complete Activity sheet 3 by putting the countries in their World Cup group in order according to their fairness score and then calculating the mean (average) for the group.
- Share their results as a whole group and then ask learners to complete Activity sheet 4. They should compare the mean (average) fairness score for each World Cup group and find the fairest and unfairiest groups and countries. Encourage learners to formulate statements based on the data such as:
 - *The most equal country in the 2022 World Cup is _____*
 - *The most unequal countries in the 2022 World Cup are _____*
 - *The most equal 2022 World Cup group is _____*
- Finish by discussing learners' responses to their findings.
 - *Which are you most surprised about, inequality between countries or inequality within countries?*
 - *What do you think a more equal country would be like?*
 - *What do you think a more unequal country would be like?*
 - *Do you think that it is right that some people have much more money than others? Why?*

Differentiation

- *Make it harder:*
 - *Learners could calculate the mean (average) fairness score for all the 32 World Cup countries or alternatively for different continents.*
 - *Learners could choose a set of data and construct a bar chart to represent the fairness scores. This could be a continent, one of the World Cup groups, or all the 32 World Cup countries.*

Further ideas

- More able learners could construct scatter graphs using the data in the *World Cup statistics table* (Resource sheet 2) or the MS Excel spreadsheet to explore relationships between different data types. Ask learners to choose two sets of variables from the table to investigate:
 - *Country incomes and FIFA rankings: Do wealthier countries have higher FIFA rankings?*
 - *Country incomes and fairness scores: Are more wealthy countries more equal?*



- *Fairness scores and FIFA rankings: Do more equal countries have higher FIFA rankings?*

Learners could use their scatter graphs to decide whether there is a link or correlation between the two variables. You may wish to discuss why their scatter graphs do not “prove” that there is or isn’t a correlation. Invite learners to share their descriptions of the relationships and discuss possible reasons for these relationships. Encourage learners to consider outliers and what factors might contribute to these.

- Explore the flags of the different nations participating in the 2022 World Cup. *What patterns can you see? What 2-D shapes and types of angles are there? Which flags have lines of symmetry?*
- Compare the distances between the capital cities (or time zone differences) of the different World Cup countries and Doha (the capital of the host country, Qatar). *Which country is furthest away? Which country has the biggest time difference?*
- Investigate data comparing the pay and working conditions of teams in different national leagues around the world. A few male professional footballers at the top of the game enjoy very good working conditions and high salaries. These footballers mostly play for the big five leagues in Europe (such as the Premier League in England). However, the majority of professional footballers, often playing in parts of Eastern Europe, Africa and some countries in South and Central America, face poor working conditions, low pay and abuse. For example, just under 2% of footballers earn more than US\$720,000 a year, whereas over 45% earn less than US\$12,000.

See FIFPro’s *Global Employment Report (2016)* for some useful facts and figures:

<https://fifpro.org/en/supporting-players/competitions-innovation-and-growth/global-employment-market-for-men-s-football/men-s-global-employment-report>

- Alternatively, explore inequality in the Premier League in England (or another national league in Europe). Collect, analyse and present data to answer questions such as:
 - *Which clubs spend the most money on wages?*
 - *Which clubs make the most money?*
 - *Who is the highest-paid footballer?*

See Deloitte’s *Annual Review of Football Finance* for some useful facts and figures:

www2.deloitte.com/uk/en/pages/sports-business-group/articles/annual-review-of-football-finance.html

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FIFA rankings

Group A	Group B	Group C	Group D	Group E	Group F	Group G	Group H
Qatar  48	England  5	Argentina  3	France  4	Spain  6	Belgium  2	Brazil  1	Portugal  9
Ecuador  44	IR Iran  22	Saudi Arabia  53	Australia  39	Costa Rica  34	Canada  43	Serbia  25	Ghana  60
Senegal  18	USA  14	Mexico  12	Denmark  10	Germany  11	Morocco  23	Switzerland  16	Uruguay  13
Netherlands  8	Wales  19	Poland  26	Tunisia  30	Japan  24	Croatia  15	Cameroon  38	South Korea  28

World Cup statistics table

Resource sheet 2

Country	Group	FIFA ranking	Average annual income per person (US\$)	Fairness score
Qatar	A	48	61,276	No data
Ecuador	A	44	5,935	47
Senegal	A	18	1,606	38
Netherlands	A	8	58,061	29
IR Iran	B	22	2,757	41
England	B	5	47,334	35
USA	B	14	69,287	41
Wales	B	19	47,334	35
Argentina	C	3	10,729	42
Saudi Arabia	C	53	23,586	No data
Mexico	C	12	9,926	45
Poland	C	26	17,841	30
France	D	4	43,518	32
Australia	D	39	69,934	34
Denmark	D	10	67,803	28
Tunisia	D	30	3,390	33
Spain	E	6	27,580	34
Costa Rica	E	34	12,509	49
Germany	E	11	50,802	32
Japan	E	24	39,285	33
Belgium	F	2	51,768	27
Canada	F	43	54,770	33
Morocco	F	23	3,497	39
Croatia	F	15	17,399	29
Brazil	G	1	7,519	49
Serbia	G	25	5,310	34
Switzerland	G	16	93,457	33
Cameroon	G	38	1,662	47
Portugal	H	9	24,262	33
Ghana	H	60	2,445	43
Uruguay	H	13	17,021	40
South Korea	H	28	34,748	31



World Cup country incomes

Make a tally to calculate how many World Cup countries fit into each income group. Express these figures as fractions and percentages of the total number of World Cup countries (32).

What do you notice about the income levels of the World Cup countries?

Income group	Tally	Total	Fraction	Percentage
Low-income country: \$1,005 or lower				
Lower-middle-income country: \$1,006 - \$3,955				
Upper-middle-income country: \$3,956 - \$12,235				
High-income country: \$12,236 or more				

Activity sheet 2

World Cup inequality ratios

Compare the average income of the three countries in the 2022 World Cup with the highest income to the average income of the three countries with the lowest income. How much more money per person do the richest World Cup countries have versus the poorest countries? Is this fair?

	Country	Average annual income per person (US\$)	Combined average income per person (US\$)	Combined average income per person (to the nearest US\$1,000)
Three highest income countries				
Three lowest income countries				

Ratio of average income of three highest income countries compared to the three lowest countries:

World Cup inequality ratios – completed table

	Country	Average annual income per person (US\$)	Combined average income per person (US\$)	Combined average income per person (to the nearest US\$1,000)
Three highest-income countries	Switzerland	93,457	77,559	78,000
	Australia	69,934		
	USA	69,287		
Three lowest-income countries	Ghana	2,445	1,904	2,000
	Cameroon	1,662		
	Senegal	1,606		

Ratio of average income of three highest-income countries compared to the three lowest countries: **39 (to the nearest whole number)**



Activity sheet 3

Fairness scores – comparing teams

Allocated group: _____

Look at the fairness scores for the four teams in the group you have been allocated.

1. Order the scores from lowest to highest:

Most equal

Most unequal

2. Find the mean score for your group:

$$\underline{\quad\quad} + \underline{\quad\quad} + \underline{\quad\quad} + \underline{\quad\quad} \div 4 =$$

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Fairness scores – comparing groups

Activity sheet 4

Collect the score for the most equal country in each group:

Group	Most fair country from each group	Average for group
A		
B		
C		
D		
E		
F		
G		
H		

Order these scores:

Collect the score for the most unequal country in each group:

Group	Most unfair country from each group	Average for group
A		
B		
C		
D		
E		
F		
G		
H		

Order these scores:

What statements can you make based on the data you have organised?

