BBC TERRIFIC SCIENTIFIC

Teacher Resource

Feet

Does environment affect foot flexibility?

Feet

Terrific Scientific Campaign

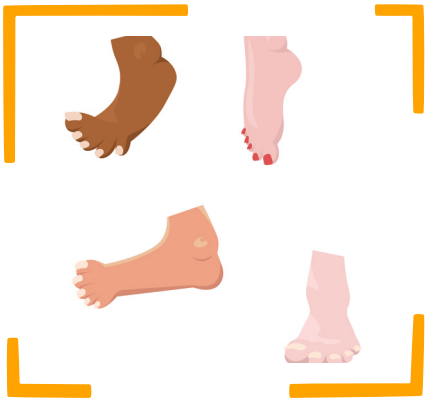
Investigation: Feet

Hello! Welcome to the Feet Investigation from the Terrific Scientific campaign!

At BBC Terrific Scientific, we think it is vital to develop science learning in primary schools across the UK. By taking part in this activity, you will be developing your class's scientific thinking and investigative skills.

At Key Stage 2 (Second Level), children need to:

- Develop investigative skills.
- Understand when it is important to control variables.
- Predict, observe and record results.
- Draw conclusions (which may generate new questions).
- Understand the need to repeat activities.
- Record what they see and not what they want to see.



We have incorporated these principles into this exciting activity. We've made it suitable for primary classrooms by using readily available equipment and suggesting opportunities for support and differentiation.

The BBC deems this activity safe if following some basic precautions. It is your responsibility as a school to carry out your own risk assessment and we recommend you consider the risks and mitigations we have described in this activity pack, as well as any risks which may be relevant to your specific class environment.

As well as these key working scientifically principles, we have made sure there are links to the science curriculum for each nation, as well as cross curricular opportunities for further learning. We think these are just as important, as they help to explain the relevance of science and how it links to the world around us.

On our website you will find a supporting 'How to' film which shows teachers and teaching assistants how to set up and carry out the experiment. You will also find additional resources including a step-by-step lesson presentation, including an introductory film which sets the investigation into context for your students.

We originally partnered with the University of Kent for this investigation. We hope this inspires you and your students to get scientific!

The Terrific Scientific Team.

Related links:

Find out more about Terrific Scientific and our other investigations on – bbc.co.uk/terrificscientific

Supported by: The University of Kent, Royal Society of Biology and Primary Science Quality Mark.

Contents

These activities encourage children to:

- Take accurate measurements of their feet.
- Learn how to manipulate these measurements to calculate their foot flexibility.
- Look for patterns in their data.

Children will show evidence of learning by:

- Making and recording accurate measurements of their feet.
- Using their results to work out their foot flexibility.
- Looking at patterns in the data linking foot flexibility and surfaces walked on.
- Explaining how animals are adapted to suit their environment.

What will the children learn? (England, Scotland, Wales, Northern Ireland)

England

Working scientifically

- Taking measurements, using a range of scientific equipment, with increasing accuracy and precision, taking repeat readings where appropriate. P177
- Recording data and results of increasing complexity using scientific diagrams and labels, classification keys, tables, scatter graphs, bar and line graphs. P177
- Reporting and presenting findings from enquiries, including conclusions, causal relationships and explanation of and degree of trust in results. P177

Evolution and inheritance

- Identify how animals and plants are adapted to suit their environment in different ways and that adaptation may lead to evolution. P184
- Recognise that living things have changed over time and that fossils provide information about living things that inhabited the Earth millions of years ago. P184

Scotland

Science experiences and outcomes

- Develop the skills of scientific enquiry and investigation using practical techniques. P2
- Develop skills in the accurate use of scientific language, formulae and equations. P2

Inheritance

- By exploring the characteristics offspring inherit when living things reproduce, I can distinguish between inherited and non-inherited characteristics. SCN 2-14b P15

Wales

Skills - Planning

- Decide upon the observations or measurements that need to be made. P13a5
- Decide upon the equipment and techniques required for the enquiry. P13a6
- Make careful observations and accurate measurements, using digital and ICT equipment at times. P13b2
- Make comparisons and identify and describe trends or patterns in data and information. P13b4

Skills – Reflecting

- Deciding whether the approach/method was successful. P13b2

Northern Ireland

Place

- Examine and collect real data. P85
- Investigating similarities and differences, patterns and change. P85
- Explore how place influences the nature of life. P85

Health & safety

This activity should be done inside. The activity should be risk assessed by the responsible teacher, and the identified control measures must be put in place before any pupil takes part in the activity. Precautions should be taken, as they would be in any similar activity run at the school. It is the responsibility of the teacher to manage this activity safely. In addition, please consider the following advice below.

- The children can leave their socks on if they prefer.
- Children should wash their hands after the activity.
- Warn the children that if the fire alarm sounds they do not stop to put their shoes on.
- Ensure the children do not push the ruler too hard under the ball of the foot.
- Ensure the children move carefully around the classroom when their shoes are off.

Important!

It is the responsibility of the teacher to manage this activity safely.

Investigating Feet

Introduction

Our bodies are amazing! They are made up of many different parts that all work together to help us carry out our daily activities. Each part is adapted to carry out a particular function. Our hearts do a great job of pumping blood around our bodies. Our stomachs are really good at breaking down food so that we can get the nutrients we need from it. There are, however, some parts of our body that we take for granted and hardly pay any attention to at all. Now is the time to stop and explore a crucial but overlooked part of our body – our feet. They are vital in enabling us to balance and stand up.

Background information

All animals and plants are adapted to their habitats. This means they have special features (adaptations) that help them to live, catch their food and survive in their environment. Arctic rabbits have white fur so they can't be easily seen in the snow by things that might eat them. Cheetahs have long, strong legs so they can run fast and catch their prey. And whales have thick layers of blubber to keep them warm in the cold seas.

Sometimes the environment can cause changes in an individual animal living within it; if an animal lives in an area with lots of food it will grow bigger than it would if it lived in an area with very little food! These changes aren't quite the same as adaptations like fur or long legs, they aren't passed down from parent to child, but they are just as important for survival!
Our feet help us to balance, run and walk and they can be flexible or inflexible. The shape and structure of human feet are an adaptation to

walking upright on two legs, but scientists think that changes to their flexibility are caused by the environment we live in.

During our original investigation in December 2017, scientists from the University of Kent were investigating how the environment affects foot flexibility. Their theory was that children who spend more time playing on even surfaces would have less flexible feet than children who spend time playing on uneven surfaces. The results gathered by children all over the UK during this Terrific Scientific activity gave the scientists a much better idea as to whether this hypothesis was correct or not.

Although the study with the University of Kent is now finished you can still complete this investigation in your class. In this series of activities, the children are going to be taking measurements of their feet. They will use this information, together with information about the type of terrain on which they spend most of their time, to see if there is a link between their range of foot flexibility and the local environment.

Expected duration: 2 hours

N.B. The second hour involves calculating and analysing results and can be done as part of a separate maths lesson)

Preparing for the investigation

These activities can be used to stimulate your students to be more curious about their feet, to look at them more closely and to consider how their feet vary.

- Ask the children to look at their own hands and feet and identify what they have in common and what is different about their hands and feet. They can gather their ideas onto the compare and contrast sheet.
- Ask the children, in pairs, to think about what they could measure to record their foot dimensions. Allow them time to take these measurements and record them on diagrams.
- Ask them to compare their foot measurements with their partners'. Can they spot any patterns? If they think they spot a pattern they can check if other people's data supports their pattern. For example, do people with longer feet have longer toes?

The children will now be aware that whilst their feet have common features they are also different. This investigation is looking at the in the variation of foot flexibility. This flexibility will vary from person to person and may also vary for one person over time due to changes in the local terrain.

We tend to think of this as how well you can point your toes, but the foot flexibility we will be measuring is different – it is a comparison of the shape of the foot when standing and sitting. This change is very small so it is really important that measurements are taken really precisely. This flexibility will vary from person to person and may also vary for one person over time due to changes in the local terrain.

Ask:

Pupils to think about what they could measure to record their foot dimensions.

Can they spot any patterns?

Main activity 1
Taking foot measurements

Equipment needed (for each pair of students):

- 2 x sheets of A4 Paper.
- 1 x pencil.
- 2 x 30cm rulers (with square edges).
- Guide on the measurements we are looking for.
- Calculator (for Arch Height Index).
- Student worksheet.

Related links:

The 'how-to' film on our website will really help you to understand how to carry out the investigation: https://www.bbc.co.uk/programmes/p05ml1hc

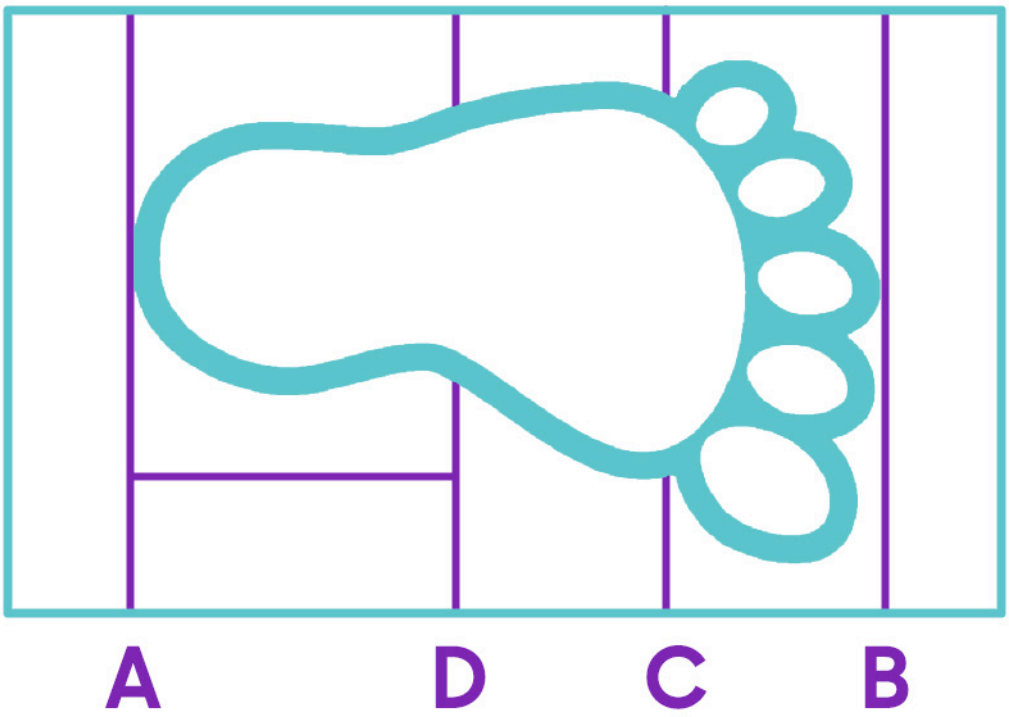
Method / procedure

- Split the class to work in pairs (assign student 1 and student 2).
- Ask children to take their shoes and socks off (any children who wish to keep their socks on can, as long as they are still able to lift their toes).

Measurements

- If the 0 cm mark is not at the bottom of the ruler you will need to do the following to get the correct height of the foot.
- Measure how far the 0cm mark is from the bottom of the ruler; record this on the student worksheet.
- You will need to add this number to the height to get the accurate calculated height of the foot.
- For example if the 0 cm mark is 4mm from the start of the ruler you will need to add 4mm to the height you measured. Please remember to add this measurement on when you record the height.

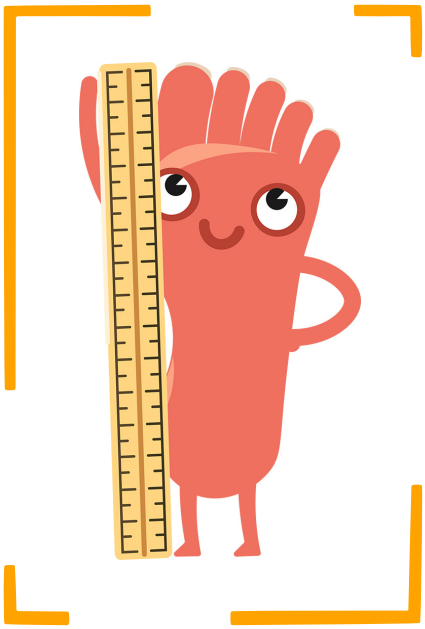
Plan view of left foot.



Place your ruler on the paper parallel to the shorter edge. Use your ruler to draw a straight line across the width of the paper. This should be the width of the ruler away from the edge.

Label this line, A.

1. Student 1 stands up and places their LEFT foot on the paper, parallel to the edge of the paper, taking care to line their heel up with Line A - making sure it touches it but isn't over the line. Placing the long edge of a ruler on the line and standing it up on its edge can provide a surface for the foot to be backed up to. When the foot is in the correct position ensure they are standing up straight with their arms by their sides, feet a shoulder width apart and heel touching this line. Make sure the student's centre of gravity is over their feet, i.e. they're not leaning forwards or backwards.



2. Student 2 should draw another straight line in line with the top of the longest toe. The longest toe is not always the big toe. Label this B.

3. Without removing Student 1's foot from the paper, carefully measure the distance between A and B and record it on your sheet.

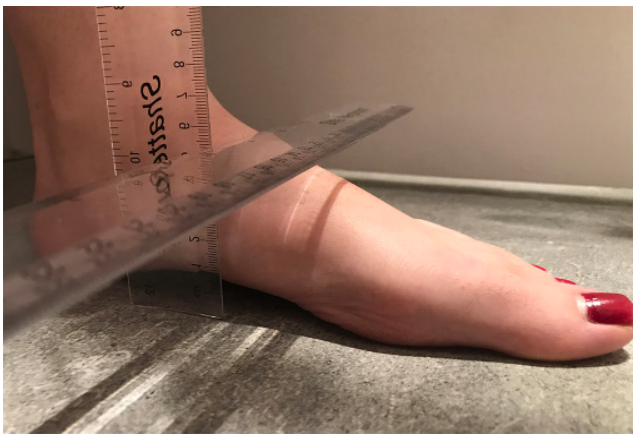
4. Calculate the midpoint between A and B, by dividing this measurement in half.

5. Use your ruler to measure and draw another straight line exactly at the midpoint. Line D on the diagram above. This is also labelled on the student worksheet.

6. Student 2 will now measure the height of Student 1's foot, stand one ruler next to the inside of the foot precisely on the midpoint line, D, you have marked. One side of the ruler must touch line D and the other should be closest to line A (see picture). Hold a second ruler on the top of the foot parallel to the floor and where it touches the upright ruler on the midpoint is the height of the foot. This will help you make an accurate measurement. Record this measurement on the pupil-recording sheet.

Tip:

When taking the standing measurement make sure students are stood with their feet a shoulder width apart.



7. Now ask Student 1 to lift up their toes a little. Slide the ruler under their toes until you feel it touch the ball of their foot. Be gentle so you do not hurt their foot. Use this ruler to draw another straight line (parallel to the short edge of the paper here) label it C.

8. Carefully measure the distance between Line A and Line C. Pupils should write this down on their worksheet.

9. Once you have all your measurements, repeat this method in full but with a new piece of paper and Student 1 sitting down while you do it. Make sure their foot is relaxed when measurements are taken.

10. Finally repeat all of this above for Student 2 both standing and sitting.

Distance from bottom of ruler to 0 cm=_____mm

	Distance A to B (mm)	Height of foot (mm)	Distance A to C (mm)
Left foot Standing			
Left foot Sitting			

Calculating foot flexibility

First you need to work out the Arch Height Index (AHI) of the foot for both the standing and sitting measurements.

To calculate AHI:

- Divide the height of the foot by the distance A to C.
- Write the AHI of each foot on your sheet. Now you can calculate how flexible the foot is.
- Divide the AHI standing by the AHI sitting.
- Record your result to two decimal places (as for this investigation we are asking pupils to work to two decimal places).
- You should get a figure between 0 and 1.
    a) 1.0 is very inflexible, 0.10 is very flexible.
- If your answer is over 1 please check all your measurements and working out again.

	AHI Standing	AHI Sitting	Foot Flexibility (AHI standing divided by AHI sitting)
Left foot			

Review

Give each child a sticky note and ask them to write down their foot flexibility to two decimal places. Show the children page 21 of this document and discuss the various animals and their foot flexibilities. Can they see any patterns?

Explain to the children that our ancestors, who were tree dwelling, would have had a foot flexibility of less than 0.5, similar to most primates today. Ask them to look at the results of the children around them - are our feet more flexible than this (lower number) or less flexible (higher number)?

The expected range is 0.75 to 0.95. If a child's foot flexibility is outside of this range discuss why this might be and allow time for these measurements to be taken again perhaps by another child to see if any of the measurements were not precise.

On the wall or white board, prepare the axes for a bar graph with the numbers spaced up the side to match the size of the sticky notes. Please plot flexibility along the x-axis using the ranges on the next page.

<0.700
0.700 - 0.749
0.750 - 0.799
0.800 - 0.849
0.850 - 0.899
0.900 - 0.949
0.950 - 1.000

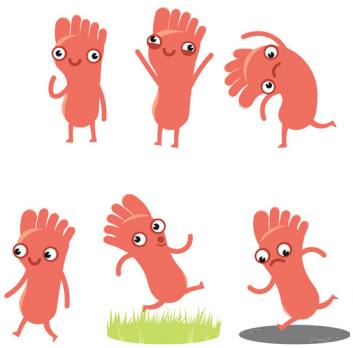
Stick the sticky notes onto the wall or the whiteboard to make a graph.
Ask the children to put their sticky note in the correct place on the bar chart.

Ask the children to talk about the graph.

- What is the range of foot flexibility in our class?
- Where are most of the points?
- Is there a pattern?
- Is there no pattern?
- Is there a pattern but with a few exceptions?

Remember:

Take a look at theTerrific Scientific map to see how your results compair with schools around the UK. bbc.co.uk/terrificscientific/map



Discuss:

Talk with the children about the graph.

Main Activity 2
Determining terrain

Ask:

Which type of surface do you spend most of your time on outside of school?

Show the children the images of the terrain (page 18 and 19.) Ask them to talk to their partner about these surfaces.

- What are these surfaces?
- What do you do on these types of surfaces?
- What is it like walking on these surfaces?
- How can we group these surfaces?

Establish that some surfaces are natural and some are man-made. It is generally easier to walk on the man-made surfaces, as these are usually more even.

Which type of surface do you spend most of your time on outside of school?

Think about:

- When you are walking from one place to another e.g. to school and back, or to a friend's houses and back home.
- The surface you play on during break and lunchtime.
- The activities you do in your spare time.

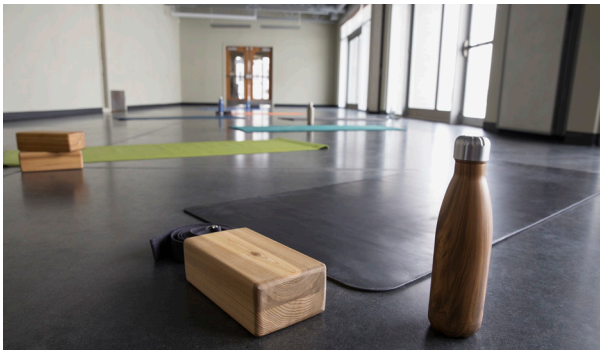
As a class decide whether they generally spend more time on natural or man-made surfaces.

Please write this on the pupil worksheet in the space provided.

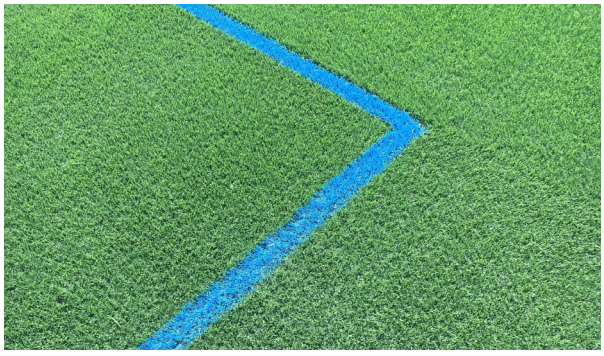
Examples of the terrain could be:

Concrete playground

Field



Gym floor



Astro turf

Pavement

Cobbled street

Country path

Woodland

Hillside

Beach (stony or sandy)

Discuss:

How has evolution adapted the animals' feet to suit their environment?

Our feet are adapted so that we can stand up and walk around. Many animals have feet that are adapted to suit the way that they move or their habitat. Ask the children to search the internet for pictures of the animals' feet outlined below. Discuss the animals' feet and how they may have adapted over time.

- Owl - the feet can bend around branches, the sharp claws help it catch and hold prey.
- Duck - the webbed feet aid with swimming.
- Otter - the webbed feet help with swimming.
- Polar bear - they are furry underneath to prevent the bear slipping on ice, the claws help to catch prey and also dig in the snow to prevent slipping.
- Horse - the solid hoof is suited to hard ground.
- Camel - the skin between the toes prevents the camel sinking in the sand.

Extension Activity 1
Measuring foot flexibility of people of different ages

Tip:

Support the children to collate this data to produce a scatter graph.

The children can use the same procedure that they have practiced during Activity 1 to collect data about the foot flexibility of people of different ages. This could be carried out during school time using children in different year groups or at home using friends and family.

Support the children to collate this data to produce a scatter graph. This can be easily done using a spreadsheet package to collect the data and then using the graph function to produce the graph. Alternatively, if the children are able to plot points they can do this by hand.

- Are there any patterns in the data?
- Does foot flexibility increase or decrease with age?

Extension Activity 2
Looking for patterns in feet

Discuss:

Does the size of your foot affect foot flexibility?

During the investigation, the children took measurements of their feet and compared these to their partner's. Their observations can be used to suggest further questions for investigation.

Example:

- Observation: I think people with longer feet have narrower feet.
- Question: Do people with longer feet have narrower feet?

The following question frame can be useful for making your own hypothesis:

- Do people with _____ have _____ ?

When the children have come up with a question, they measure as many people as possible to gather sufficient evidence to support or refute their idea. Plotting their results on a graph will enable them to notice if any patterns in the data are present.