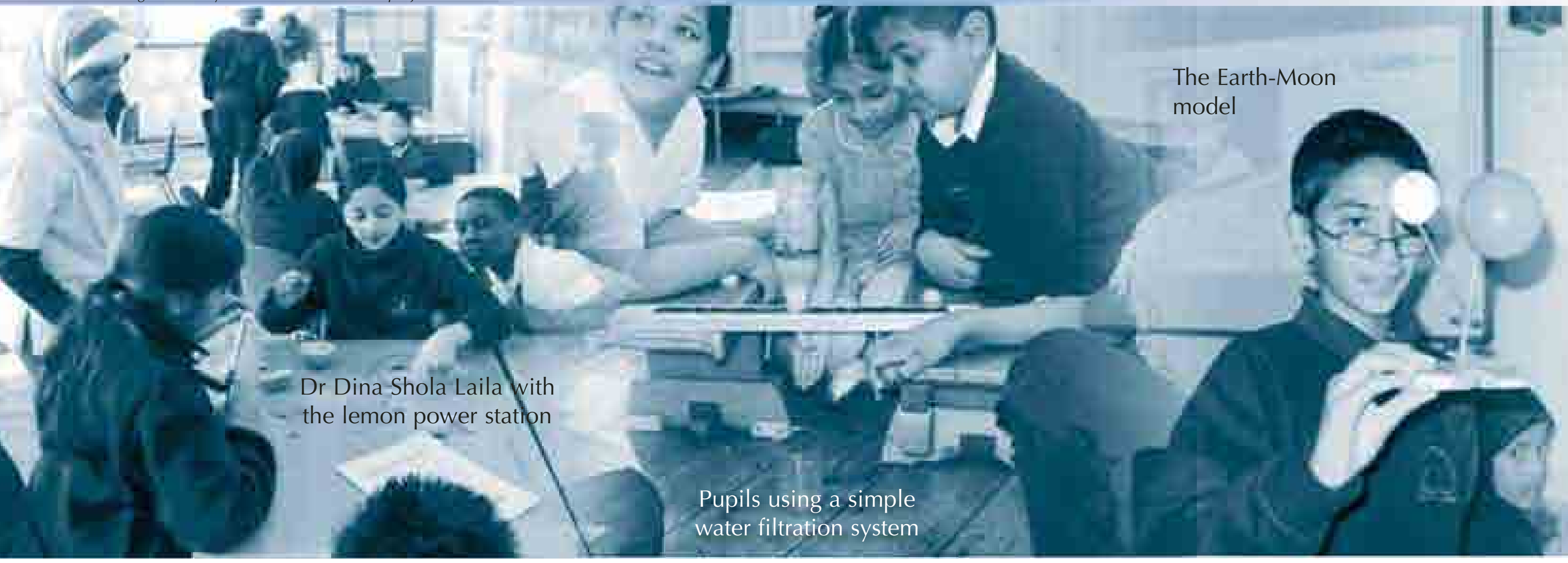
Images courtesy of the Next Generation project



Science for the Next Generation: activities for primary school

The Next Generation project promotes a better understanding of the wonderful world of science to primary-school children. A team of postdoctoral scientists from Imperial College in London, UK, worked with the teachers from Salisbury Primary School in East London to develop a series of practical two-day science workshops. These workshops provide exciting hands-on experiments using everyday household materials to help the children explore the simple science principles that are found all around them. Below are three of the activities for you to use in your classroom.

Water filtration system

This experiment looks at solids and liquids and examines how to separate them, placing what pupils have learned in the classroom into a real-world setting. Pupils learn how to design and build a simple water filtration system using a variety of materials. Each material is suited to separating different sized solids and dissolved particles from water. The pupils learn, through trial and error, what each material is most appropriate for.

To put the topic into context, you will need to give the pupils a brief introduction to the importance of treating wastewater so that it is safe to be released into rivers. Wastewater treatment is typically a three-stage process consisting of preliminary treatment to screen out large solid impurities, primary sedimentation to remove impurities through sorption to solids, and secondary treatment to break down or degrade the remaining impurities using micro-organisms.

This experiment investigates the physical process of removing solid impurities of varying sizes and the chemical process of removing dissolved particles by sorption to charcoal. The pupils can discuss what makes water dirty, emphasising key terms such as solid waste, dissolved impurities, filtration and micro-organisms.

The experiment investigates the primary treatment, i.e. the removal of solid impurities. A worksheet is provided for the pupils to complete in support of this experiment.

Wayne A Mitchell, Debonair Sherman, Andrea Choppy and **Rachel L Gomes** from the Next Generation project describe some of their science activities to introduce primary-school children to the science all around us.

Materials

- Cotton wool
- Sand
- Charcoal (preferably powdered, or buy charcoal pieces and grind them up)
- Gravel
- Plastic glasses
- An empty water bottle with the bottom cut off
- A support system for the water bottle, e.g. a plank of wood with a hole
- Dirty water (water with instant coffee, flour and charcoal pieces added)
- An empty container for used materials and dirty water
- Stopwatches

Method

1. The pupils should set up their filtration system, placing the empty water bottle upside-down into the support system. We used a plank of wood between benches or tables.
2. For each filtration system, give the pupils the four materials (cotton wool, sand, ground charcoal and gravel) in separate glasses along with a glass of the dirty water.
3. Let the pupils choose the order in which to pack layers of the materials into the water bottle. Have them note the order of the packing material and predict how effectively the filtration system will remove impurities from the water. Ask the pupils to measure the time taken for the water to pass through the system and to predict how this affects the cleaning process.
4. When the filtration system is packed with the materials, the pupils can add the dirty water. Depending on the packing, it can take a while for the water to pass through the packing layers. Often, the pupils forget to place an empty glass underneath but they will learn for the next time!

Through trial and error, and observation, the pupils will learn that the best approach for cleaning the water is to pack the materials in order of size. The cotton wool needs to be placed at the bottom (in the neck of the bottle), to prevent the other packing materials from falling through. Above the cotton wool comes the ground charcoal, then the sand, and then the gravel. (As an optional extension to this exercise, the thickness of the layers can also be varied to see how this affects the purification process.)

From this experiment, the pupils will learn that each packing material is suited to different types of solid impurities in the dirty water and, when combined to make an effective water filtration system, must be packed in order of size. The sand and gravel separate or filter out solids of different sizes (sand removes the smaller particles). The powdered charcoal adsorbs the dissolved coffee, taking away the colour. Additionally, by the time the dirty water has reached the charcoal, it is trickling very slowly, which gives it more time in contact with the charcoal. The longer the dirty water is in contact with the powdered charcoal, the more time the charcoal has to adsorb the colour. The cotton wool prevents any of the other filtration materials from falling out of the bottle.

This experiment demonstrates that impurities in dirty water can be removed by using a series of barriers, which use either physical (filtering by gravel and sand) or chemical (sorption using powdered charcoal) processes to remove the impurities. This type of treatment would not be effective on micro-organisms, however. Can you think what could work well instead?

Worksheet:
Water filtration system

Name: ____________________ Date: ____________________

Class: ____________________

What makes water dirty?

1. ____________________ 2. ____________________

3. ____________________ 4. ____________________

A water filter can be made using what four objects?

1. ____________________ 2. ____________________

3. ____________________ 4. ____________________

Draw a picture of your water filtration system and add labels to explain:

Part of the water filtration system	What does it do?
Bottle	
Cotton wool	
Charcoal	
Sand	
Gravel	

How does a water filtration system work?

Why is it important to clean water?

Construction of an Earth-Moon orbital model

The construction of the Earth-Moon orbital model will help pupils understand the basic movements of planets in space and provide them with a lasting – and homemade – reminder of the activity. The orbital can be used to introduce the principle of planetary movement around the Sun and also the orbit of the Moon around Earth.

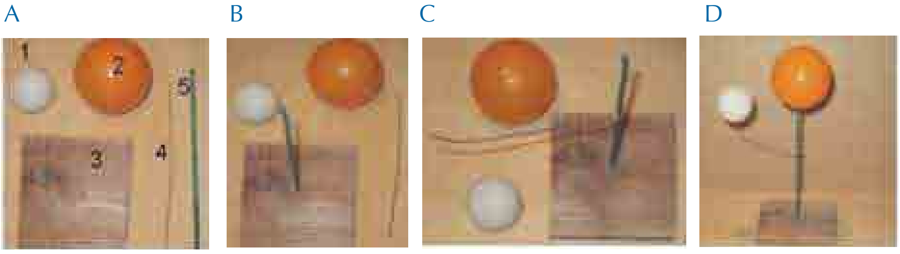
Furthermore, by using an external light source such as a desk lamp, pupils can examine the phases of the Moon as well as the concepts of solar and lunar eclipses.

Apparatus

- A piece of copper wire (10-15 cm long by 3 mm thick)
- A small wooden stick (15-18 cm long by 5 mm thick)
- 2 table-tennis balls (or use polystyrene balls of different sizes)
- A wooden base (10 x 5 x 1cm)
- A drill and a 5 mm drill bit

How to construct the Earth-Moon orbital

1. Drill a hole through the centre of the wooden base.
2. Insert the 15 cm stick into the hole.
3. Secure the copper wire to the middle of the stick by making two complete turns. The wire should remain firmly connected to the stick.
4. Using a pointed object (such as a small nail), make a small incision into the two table-tennis balls.
5. Place one table-tennis ball (representing either a planet or the Moon) on the free end of the copper wire – which will act as the orbital arm – and the second ball (representing either the Sun or Earth) on top of the wooden stick. Adjust the copper wire with the table-tennis ball to a position where the two balls are lined up with each other. If correctly constructed, the orbital arm will rotate around the central ball.



Images courtesy of the Next Generation project

Earth-Moon orbital construction: **A**) Apparatus needed for the Earth-Moon orbital; **B**) Insert the wooden stick into the wooden base; **C**) Attach the copper wire to the stick; **D**) Attach the balls to the stick and the copper wire

The model can be used to demonstrate the Moon's orbit around Earth or different planets in the Solar System orbiting the Sun.

Using an external light source to represent the Sun, the relative positions of the Moon and Earth can be used to examine the different phases of the Moon. For example, ask the class to observe what happens when the Moon is placed between the light source and Earth (no sunlight reflected from the Moon can be seen from Earth – no moon in the night sky), or when Earth is between the light and the Moon (all the sunlight reflected from the Moon can be seen from Earth – full moon). By placing the Moon in different positions relative to Earth (e.g. change the position by 45 degrees), the class can describe the amount of moonlight seen from Earth. This can be used to explain the different phases of the Moon.

Another suggested project is to ask the class to draw the shape of the Moon every night for one month; the drawings can then be used to chart the different phases of the Moon.

To investigate planetary movement around the Sun, additional orbitals can be attached to represent further planets and allow the class to examine the effects of planetary distance from the Sun on the planets' temperature, or the amount of time to complete one rotation of the Sun.

A useful website to accompany this project is the National Schools' Observatory demonstration of phases of the Moon[w1].

Yeast balloon

This experiment can be used to investigate topics including micro-organisms and gases all around us. Pupils are encouraged to design an experiment to test different variables which affect yeast's ability to grow, and to investigate a by-product of this process, carbon dioxide.

Start by asking the children for their ideas on how humans use yeast and other micro-organisms as part of our everyday lives. Provide pictorial examples such as blue cheese, bread, beer, compost heaps and bacterial cultures. These examples demonstrate that micro-organisms are important for human survival. Ask the children what they think micro-organisms need to survive, and how humans have used this knowledge. You will need to explain that gas is produced as a result of yeast growth; ask the children if they know which gas is produced.

Ask the children to design an experiment that tests the conditions needed for yeast to survive, using the apparatus listed below. After they have planned their experiments, provide the children with the apparatus. They can use a variety of approaches to measure the gas produced, such as using string to measure the circumference of the balloon, or bubbling the gases into an inverted measuring cylinder filled with water to measure the volume.

Apparatus

- Three large balloons
- Three 500 ml plastic bottles
- Water
- Three 7 g packets of yeast
- Sugar
- Vinegar
- A thermometer

Table 1: Examples of experiments and demonstrations developed as part of the Next Generation project

Experiment/Demonstrations	Topic	Scientist
Water filtration system	Solids and liquids: how to separate them	Arun Arora
Woodlouse and maggot race	Movement and growth	Rachel Gomes
Liquid nitrogen	Solids and liquids: changing states	Gavin Jell
Lemon power station	Interdependence and adaptation	Dina Shola Laila
Pondweed and light	Interdependence and adaptation	Wayne Mitchell
Slinky soundwave	Changing sounds	Valerie Nadeau
Glitterbug	Micro-organisms	Catherine Reynolds
Heat in space	Earth, Sun and Moon	Berangere Tissot

- String
- A ruler
- Artificial sweetener (optional)

Method

1. Divide the class into groups.
2. Each group should design an experiment to test one or more variables affecting carbon dioxide production by yeast. To ensure a fair test, one condition must always remain the same; for example, you can change the amount of yeast placed into two bottles while making sure that the amount of water and temperature remains the same in both.
3. Pupils can choose to change variables including:
   - Temperatures ranging from room temperature to 60 °C
   - Amount of sugar
   - Type of sugar (e.g. artificial sweeteners)
   - Acidity of environment (vinegar).
4. Each group of pupils should draw up their experimental plan and hypothesis before starting their experiment. Encourage the pupils to make predictions of what they would expect to happen.
5. Once the groups have prepared their experimental plan, supply each group with 2 or 3 plastic bottles and balloons.
6. Pupils should measure and record the exact changes made to each variable.
7. The pupils can measure the amount of carbon dioxide evolved either by measuring the diameter of the balloon or by dipping the balloon into a measuring cylinder of water to calculate its volume.
8. The class could have a competition to see who can get the most carbon dioxide out of their yeast.

Allow the experiments to run for about 20 minutes before discussing the results. Pupils should state whether the results of their experiments agree with their predictions.

Ask the children as a group to identify the best conditions for yeast growth; they should suggest warm water and sugar. The pupils can also discuss what conditions prevented the growth of yeast: no sugar, cold water, or the presence of acids. What would happen if you use honey instead of sugar?

You can extend the lesson by investigating the nature of the gas produced – by weighing the balloon, or testing the effect of the gas on lit and glowing splints. The pupils could also try experiments to demonstrate how micro-organisms contribute to the gases all around us.

A description of the experimental set-up is available on the Exploratorium website[w2].

More activities from the Next Generation project

The table above shows some of the other activities developed as part of the project. More information on the science activities used in the project,is available on the Next Generation website[w3].

The Next Generation project fosters close working partnerships between scientists and teachers. Delivering science in an engaging and informative manner is the catalyst to encouraging a better and wider understanding of science for our children. In time, it is hoped that some of the pupils involved will become the next generation of scientists, sparking interest in science among future children.

If you would like more information about the Next Generation project, please contact Wayne Mitchell (w.mitchell@imperial.ac.uk).

Web references

w1 – The National Schools' Observatory website includes a demonstration of phases of the Moon over time: www.schoolsobservatory.org.uk/astro/esm/moonphs.shtml

w2 – The website of the Exploratorium in San Francisco, USA, includes further instructions for the yeast balloon experiment: www.exploratorium.edu/cooking/bread/activity-yeast.html

w3 – The Next Generation website includes information about many science activities developed for primary schools: www.ng-project.com