Tap Supply

To investigate how engineers filtrate and distribute water

Subject(s): Science, Design & Technology, Mathematics

Approx time: 30-45 min

Key words / Topics:
- clean water
- health
- filtration
- water supply
- treatment systems
- engineers
- budgeting
- profit
- percentages

Suggested Learning Outcomes

- Describe how water filtration equipment acts in a number of different ways to produce potable (drinkable) water
- Explain why it is important to work within a budget
- Develop a logical approach to describing complex systems

Introduction

Water is crucial to human life, but it can also be a killer.

Water contaminated with micro-organisms or chemicals, which is then used for drinking or cooking, is a leading cause of disease and death across the world. Fresh water is increasingly becoming a commodity. However, there is plentiful supply of seawater…but using it may be more expensive than expected!

These classroom resources focus on how engineers and scientists work to efficiently provide us with safe, clean drinking water.

Purpose
This activity challenges students to work in small teams to design a water supply system for Drymouth, a small town of 5,000 inhabitants. Students can also carry out a practical desalination experiment. The activity offers strong opportunities for cross-curricular work with Enterprise.

Activity

Present the scenario given on the 'Build a Safe Water Supply System' briefing sheet *(ca. two minutes).*

Students should work in small teams. Once students have designed their system, they will need to add up the cost and add a profit margin for themselves.

This will give them the cost at which they will need to sell their particular system in order to make a profit.

Each team will then have one minute to present their

Teacher notes

Distribute the following to each team:

DOC Build a Safe Water Supply System (Brief)

DOC Catalogue of Components (Handout)

Explain to students that they will be given a 'catalogue' from which to choose components. It will be entirely up to each team which components they want to use and how many they want to use.

system to the rest of the group and face a vote for the winning system, which will provide the best (i.e. cleanest of impurities including bacteria, micro-organisms, sediment etc.) water supply at the most reasonable price that is most free from contamination.

Explain that they only have to create a schematic diagram – pipes can be represented with lines and components with labelled boxes.

Students will also need to think carefully about the order in which they put their components. For example, a sedimentation tank is best placed at the beginning of the process to remove large particles before they can clog up other parts of the system. A UV treatment system needs to go at the end of the process so the water is clear enough to let the radiation penetrate far enough to kill all the micro-organisms. It can then also kill any micro-organisms that may have been introduced at other points in the process. *(ca 25 minutes)*

Students present back to the rest of the class. Teacher and class feedback on the effectiveness of their planned systems. Main points on the whiteboard to help teams with their voting. *(ca 10 minutes)*

If time allows, students can play the game 'Outbreak'. This is an effective way to learn more about the link between water supply and disease. Students can compare scores at the end of the lesson.

Point out that they must check the flow rate data for each component as they need to make sure that flow rates match from one stage of the process to the next. For example, a sea water pump can lift 250,000 litres per day, but a sedimentation tank can only deal with 50,000 litres per day. So each sea water pump will need to be connected to five sedimentation tanks for the system to work efficiently.

Students can alternatively present their system in 'corners'. For example, whereby team 1 presents to team 2 in a corner of the room, while team 3 presents their system to team 4 in another corner of the room, and then they change over. A 'speed dating' approach. This uses less time and everyone gets to have a go without it becoming stale.

Note: All data included in the component catalogue is for the purposes of this exercise only and is not intended to be indicative of any real values. In order to keep the exercise manageable, there is assumed to be no water loss at any point. In reality, there would be a considerable loss of water, particularly in the reverse osmosis unit which would typically lose between 85% and 95% of the water entering the system as waste.

Differentiation

Basic

- Students could be given the components as a card sort and an outline of the schematic diagram. Students could then work in small groups to order the components and explain their choices.
- Ignore the flow rate data and ask students to concentrate on getting the components in the right order. The *game Sip of Sewage* will provide a useful plenary activity.
- It might also be useful for students to have a broader idea about the relationship between clean water and

Extension

Ask students to take into account the information about the loss of water from the reverse osmosis (RO) unit as part of their design. This will require the students to calculate a new value for water flow after the RO unit. Students will then have to compensate for the loss from this unit by introducing more pumps and other equipment before the RO unit in their system design.

human health and how scientists and engineers are involved in this process. The short *Pure Water* and *Safe Water videos* will provide a useful start to the lesson in this case

Resources

Required files

Build a Safe Water Supply System (Brief)

Catalogue of Components (Handout)

Additional websites

> Wikipedia: Entry for 'Desalination plant' (http://en.wikipedia.org/wiki/Desalination_plant) gives a good report on the various methods of sea water desalination
> Wikipedia: Entry for 'Water purification' (http://en.wikipedia.org/wiki/Water_purification) gives a reasonable overview of water purification methods
> HowItWorks.net: The web page entitled 'How Water Filters Work – An Explanation of Good Taste' (www.howitworks.net/how-water-filters-work.html)gives an explanation of how water filters work
> Wikipedia: Entry for 'Reverse osmosis' (http://en.wikipedia.org/wiki/Reverse_osmosis) has a good explanation of reverse osmosis

Related activities (to build a full lesson)

Starters (Options)
> FILM (The story): Pure Water
> FILM (The story): Saving Water
> FILM (How it works): Reverse Osmosis Purification
> FILM (Who makes it work): Shivaji Deshmukh
> ACTIVITY: Engineers Can Save Lives
> ACTIVITY: Killer Water
> ACTIVITY: Spreading Disease

Main (Options)
> ACTIVITY: Filtering the Truth
> ACTIVITY: Filtering Water

Extension (Options)
> ACTIVITY: **Tap Supply**
> ACTIVITY: Water Treatment Systems

Plenary
> GAME: Outbreak
> GAME: Sip of Sewage
> QUIZ: World Water
> Opportunities within activity for presentations, peer/self assessment
> Reflection on Objectives and PLTS skills used

The Engineering Context

- **The story** Pure Water
- **The story** Saving Water
- **How it works** Reverse Osmosis Purification
- **Who makes it work** Shivaji Deshmukh

Curriculum links

England: National Curriculum

Science
- KS3 17b, 17d
- KS4 1.2b, 1.3b,c, 1.4a,b, 2.4a

Design & Technology
- KS3 1d, 1e

Mathematics
- KS3 1a, 1b, 2a, 2f, 3a, 3b, 3c, 3d, 4a, 4d, 4m, 4o
- KS4 1.1a, 1.1b, 1.3b, 2.1a, 2.2l, 3.1b, 4d

Northern Ireland Curriculum

Science
Developing pupils' knowledge, understanding and skills
- Organisms and health
- Chemical and material behaviour

(Objective 1) Developing pupils as Individuals
explore the physical, chemical and biological effects on personal health
(Objective 3) Developing pupils as Contributors to the Economy and the Environment
- investigate the effects of pollution e.g. water and specific measures to improve

Technology & Design
Developing pupils' knowledge, understanding and skills
- design – identifying problems; investigating, generating, developing, modelling and evaluating design proposals; giving consideration to form, function and safety

(Objective 2) Developing pupils as Contributors to Society
- explore technical inventions and designs that have met a social need cost-effectively;
- design cost effective and appropriate solutions to meet the specific needs of diverse local and global groups.

(Objective 3) Developing pupils as Contributors to the Economy and the Environment
- identify product needs and pursue sustainable harmonious design solutions in a local outdoor/indoor context.

Learning Outcomes
- show deeper understanding by thinking critically and flexibly, solving problems and making informed decisions, using Mathematics and ICT where appropriate;
- work effectively with others;
- demonstrate self-management by working systematically, persisting with tasks, evaluating and improving own performance;
- communicate effectively in oral, visual (including graphic), written, mathematical and ICT formats showing clear awareness of audience and purpose.

Mathematics and Numeracy
Developing pupils' knowledge, understanding and skills
- the application of mathematical skills to real life and work situations

(Objective 3) Developing pupils as Contributors to the Economy and the Environment
- explore how the skills developed through mathematics will be useful to a

	range of careers > understand the need to manage renewable and non-renewable resources Learning Outcomes > demonstrate mental mathematical capability in a range of everyday contexts > demonstrate financial capability in a range of relevant everyday contexts
Scotland: Curriculum for Excellence Sciences Materials: Chemical Changes > SCN2-18a Topical Science > SCN2-20a Technologies > TCH 3-01a, TCH 3-02a , TCH 3-07b Numeracy and Mathematics MNU 3-03a, MNU 4-03a, MTH 4-06b, MNU 3-11a, MTH 4-13b, MTH 4-16b, MNU 4-20a	**Wales: National Curriculum** Science > KS3 Range (Interdependence of organisms 7) Design & Technology > KS3 Skills (Designing 1, 2, 3, 4, 6, 7, 8, 9) Mathematics KS3 and KS4 Skills (Solve mathematical problems) > use a range of mental, written and calculator computational strategies KS3 and KS4 Skills (Reason mathematically) > justify how they arrived at a conclusion to a problem; give solutions in the context of the problem; confirm that results are of the right order of magnitude KS3 and KS4 Range (Calculate in a variety of ways) > use a calculator efficiently to plan a complex calculation > calculate with whole numbers, negative numbers, decimals, fractions, percentages and ratios, understanding the effects of the operations KS3 and KS4 Range (Understand and use money) > calculate with money and solve problems related to budgeting, saving and spending, including currency exchange rates, profit and loss, discount, hire purchase, best buys, household bills and compound interest

Assessment opportunities

> The presentation could be recorded and used as APP evidence.

Personal, learning & thinking skills (PLTS)

> Creative Thinker
> Team Worker