

Investigating the maths inside:

Cleaner coasts

Information for teachers



*Maths Inside* is a project funded by the Commonwealth Department of Education and Training under the Australian Maths and Science Partnership Programme.

The aim of *Maths Inside* is to increase engagement of students in mathematics by using rich tasks that show the ways mathematics is used in real world applications.

# About this module

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This module consists of the video *Cleaner coasts* and the following activities:

Activity 1: A rubbish audit Years 7 to 9

Activity 2: When does it decay? Years 7 to 9

Activity 3: From shop to shore Years 6 to 9

# Background

Rubbish and the disposal of rubbish is an ongoing problem in many countries around the world. Should things be re-used, re-cycled, incinerated at high temperature or sent to landfill? How long does rubbish last in the environment? What damage does it cause?

These are ongoing questions, especially when we hear that some discarded materials take many years to break down and can end up in the food chain, through various means, especially through waterways. Students will investigate some of these issues by considering school yard rubbish and how long it lasts.

Activity 1: The school rubbish audit

Students organise an audit of the places where rubbish collects around the school. They quantify the amount of rubbish and convey this information on a school map using a variety of representations.

Students make recommendations for reducing the amount of rubbish by analysing the data.

# Why do this?

This activity provides a way of quantifying the problems that are caused by our ‘disposable’ society and the rubbish it generates. Through a school rubbish audit, students get a better understanding of the amount of rubbish in the school yard, and the places that it collects. This relates directly to the sources of rubbish that can end up in our waterways and oceans.

Students use different kinds of representations, such as heat maps and dot maps, to display their data simply and effectively.

# Australian Curriculum links

#### Year 7: Statistics and probability – data representation and interpretation

Identify and investigate issues involving numerical data collected from primary and secondary sources (ACMSP169)

Construct and compare a range of data displays including stem-and-leaf plots and dot plots (ACMSP170)

#### Year 8 Statistics and probability – data representation and interpretation

Investigate techniques for collecting data, including census, sampling and observation (ACMSP284)

Explore the practicalities and implications of obtaining data through sampling using a variety of investigative processes (ACMSP206)

#### Year 9: Statistics and probability – data representation and interpretation

Identify everyday questions and issues involving at least one numerical and at least one categorical variable, and collect data directly and from secondary sources (ACMSP228)

# Getting started

Begin with a discussion on the problems of rubbish disposal in our society. These websites are a good stimulus.

<https://environmentvictoria.org.au/resource/problem-landfill/>

<http://www.theage.com.au/victoria/rubbish-dump-time-bombs--and-there-may-be-one-near-you-20160520-gozo64.html>

# The school rubbish audit: Where?

## Planning

There will be some obvious hot-spots for the accumulation of rubbish, such as the canteen or eating areas. Significant amounts of rubbish might be found in other spaces, such as fence-lines, sports fields, and garden beds. A preliminary survey of the school grounds beforehand will give students an idea of where these spaces are and a sense of the amount of rubbish they contain.

Give groups of students a school map or use a Google map. Using the preliminary survey divide the grounds into regions. Allocate one region to each group.

## The audit

The class will need to decide how they will categorise the amount of rubbish (i.e., not actually counting it). For the purposes of a heatmap, a minimum of three categories is needed. One suggestion is ‘nil’, ‘light’, ‘medium’ or ‘heavy’.

It would be useful to take some photographs of typical examples to help reach agreement.

Decide at what distances (or areas) the categorisation should occur (e.g. every two metres along a fence or building line, over 5-metre squares on the oval).

## Representing your information

There are several ways of representing the information.

For example, students could superimpose a ‘heat map’ over the school map to highlight the messiest through to the cleanest areas. Information on heat maps can be found at <https://en.wikipedia.org/wiki/Heat_map> or in the Maths Inside activity ‘Making sense of complex information’ found in ‘Big data, better hospitals’. Alternatively, they could colour code the regions by hand, rather than using excel.

Another possibility is to use a ‘dot map’ where the size of the dots indicates the amount of rubbish gathered in each different place.

Students may have other suggestions. It would be a useful exercise to compare the different types of representations for their effectiveness in communicating the information.

# What next?

Discussion on the factors affecting areas where lots of rubbish collects may include location (for example, near the canteen or dedicated eating areas), school design (such as isolated areas, type of fencing, garden beds) or local conditions (for example, prevailing winds, proximity to a shopping centre or main road).

The discussion on the school action plan will depend very much on the physical layout of the school.

Where should the bins be? Are there enough? Are there recycling bins? Can ‘catchment areas’ be improved?

# Extended investigation

Each of the three activities present opportunities for the school community to help protect their local waterway through a school action plan. A more comprehensive approach can be achieved by combining two, or even three, of the activities. It may be possible to include other year levels in the collection and analysis of the data.

# Resources needed

Copies of the school map for each group

Access to Excel (if creating heat maps digitally)

Coloured pencils or markers

Activity 2: When does it decay?

Students audit the contents of a typical school bin, by categorizing, then counting the different types of rubbish.

They research how long it takes for different items to break down, and then create a decay timeline for the types of rubbish that were found in the bin.

Students then assess what rubbish might be remaining in the schoolyard after different periods of time, and make some suggestions about rubbish disposal at school.

# Why do this?

This activity provides a way of quantifying the problems that are caused by our ‘disposable’ society and the rubbish it generates. There are potential curriculum links to science, history and geography.

Students become aware of the difficulties of displaying data with extreme values. There is the opportunity to consider logarithmic scales.

# Australian Curriculum links

#### Year 7: Statistics and probability – data representation and interpretation

Identify and investigate issues involving numerical data collected from primary and secondary sources (ACMSP169)

Construct and compare a range of data displays including stem-and-leaf plots and dot plots (ACMSP170)

#### Year 8: Statistics and probability – data representation and interpretation

Investigate techniques for collecting data, including census, sampling and observation (ACMSP284)

Explore the practicalities and implications of obtaining data through sampling using a variety of investigative processes (ACMSP206)

#### Year 9: Statistics and probability – data representation and interpretation

Identify everyday questions and issues involving at least one numerical and at least one categorical variable, and collect data directly and from secondary sources (ACMSP228)

#### Year 9: Measurement and geometry – using units of measurement

Investigate very small and very large time scales and intervals (ACMMG219)

# Getting started

There are long term problems with rubbish disposal. Some scientists suggest that plastics never fully break down. You may have heard of the ‘Pacific garbage patch’ or read stories about cities that collect their rubbish in container ships for dumping at sea, only to have it wash back up on shore at some time later. Even rubbish dumps referred to as ‘landfill’ have a limited lifespan.

Have a class discussion about students’ knowledge of rubbish disposal: reduce, reuse, recycle (for example, banning of plastic bags, recycling bins, compost bins, op shops).

How long do certain materials take to break down? Ask students to estimate times for a few items (for example, an apple, a piece of newspaper, a plastic drink bottle, fishing line, disposable nappy). Record the range of each of their estimates to refer to later in the lesson.

A table on the length of time that rubbish lasts, such as that found at <http://www.kabc.wa.gov.au/library/file/Fact%20sheets/How%20long%20Fact%20sheet%20KAB.pdf> might be useful to stimulate the discussion and highlight possible long term problems that rubbish disposal causes.

# What’s in the bin?

Select a bin(s) which is likely to have a variety of rubbish.

You will need a large plastic sheet (such as a heavy-duty garbage bag cut to lie flat) or thick layers of newspaper (a good model for reusing material!) to lay out the rubbish.

Students should wear rubber gloves (ones that can be cleaned rather than disposable ones, if possible) and use tongs to handle the rubbish.

The students categorise the rubbish into different types of materials. Some will be obvious (such as soft and hard plastic, food scraps), others may be more difficult, especially if they are made of several different materials.

There may need to be some discussion on how to ‘count’ the amount of rubbish, for example, pieces of orange peel versus aluminium cans. The point of the count is to get a sense of what kind of rubbish is more prevalent and relate it to the local environment.

## What kind of rubbish?

There are lots of questions that can be asked in order to find the information necessary to help establish recommendations for future action.

What is the common type of rubbish? The least common? Are there particular foods sold at the canteen which have unnecessary or undesirable packaging? What is thrown away that could be reused or recycled?

# The rubbish timeline

The timeline is a way to visualise the length of decay times and put them into a context relating to the students.

## How long?

Be aware that there can be significant differences between the times cited. Decay is dependent on the conditions, for example, the amount of moisture, exposure to air, the temperature or other environmental factors.

Often there is a range of times given. Perhaps one group could use the minimum times, another the maximum times and another the midpoints.

## Create a timeline

This may well provide some significant challenges, as the times could vary from a few weeks to ‘forever’!

Students can choose what life events might also be indicated on the timeline (starting school, leaving school, buying a house etc)

They will need to use consistent units for graphing.

One way to represent the data would be to use a large number of pieces of paper and join them together, along a wall, around the room, down the corridor. Students will need to decide a scale that will suit the length of the display.

Another possibility is to divide the types of rubbish into time groups and have separate displays, one dealing with months, another with years, another with hundreds of years.

# What next?

Discussion on the factors affecting what kind of rubbish appears may include the type and packaging of food and beverages offered at the school canteen, and the number and accessibility of recycling stations (including compost bins).

The discussion on the school action plan will depend very much on the type and quantity of the rubbish collected at the school.

Should the school community be encouraged to bring reusable water bottles and ‘keep cups’ for hot beverages? What about a ‘nude food’ week? At school functions is recyclable cutlery used? Are there recycling bins?

# Extended investigation

Each of the three activities present opportunities for the school community to help protect their local waterway through a school action plan. A more comprehensive approach can be achieved by combining two, or even three, of the activities. It may be possible to include other year levels in the collection and analysis of the data.

# Further ideas

Some students may be interested in the idea of compressing the scale so that all the data can fit onto one graph. There is the opportunity to introduce informally logarithmic scales.

Activity 3: From shop to shore

Students watch a PowerPoint highlighting the problems of rubbish in our waterways and oceans, especially its impact on living organisms (including people!). They explore ways to inform the community, suggesting changes in behavior.

Students analyse real data provided by Sydney Water to quantify the amount of rubbish collected.

# Why do this?

This activity provides a way of quantifying the problems that are caused by our ‘disposable’ society and the rubbish it generates, on a broader scale beyond the school community.

Students manipulate spreadsheets to analyse real data. They apply measurement skills to compare familiar school contexts to the volume of rubbish collected.

There are opportunities to link to other curriculum areas such as geography, science and social science, as well as addressing many of the General Capabilities.

# Australian Curriculum links

#### Year 6: Measurement and geometry – using units of measurement

Convert between common metric units of length, mass and capacity (ACMG136)

#### Year 7: Statistics and probability – data representation and interpretation

Identify and investigate issues involving numerical data collected from primary and secondary sources (ACMSP169)

#### Year 7: Measurement and geometry – using units of measurement

Calculate volumes of rectangular prisms (ACMMG160)

#### Year 8: Measurement and geometry – using units of measurement

Choose appropriate units of measurement for area and volume and convert from one unit to another (ACMMG195)

#### Year 8: Number and algebra – real numbers

Solve a range of problems involving rates and ratios, with and without digital technologies (ACMNA188)

#### Year 9: Statistics and probability – data representation and interpretation

Identify everyday questions and issues involving at least one numerical and at least one categorical variable, and collect data directly and from secondary sources (ACMSP228)

# Getting started

Show the slideshow from Slide 1 to Slide 13. This will give the necessary background.

in the slideshow, there are a number of links to articles and videos. You may choose to read/watch these together, or ask small groups to report back on individual items to the class.

# The slide-show

## Slides 2­–6

These can be shown quickly to set the scene. All photos were taken in Sydney.

## Slide 7

This slide shows the main Sydney waterway connected to the ocean. Ask the class to identify your local waterway.

## Slide 8

Many students would have heard of, or visited, Bali. What do they think that the island is like? What does this slide tell them?

## Slides 9–13

These slides examine the devastating impact of plastic on wild-life and humans. Please view the linked videos to assess their suitability for your group of students.

## Slides 14–20

This set of slides provides some suggestions for actions to reduce the amount of waste in waterways.

## Slides 21–22

Governments take action beyond the individual.

Slide 22 has questions about the Cooks River in Sydney. This slide can be omitted if it does not relate well to your school context.

## Slides 22–26

These slides outline a possible case study, using data on the amount of rubbish removed in the Cooks River by litter booms every month. There is a link to an Excel spreadsheet of the data (MI\_Coasts\_Activity3\_ShopShore\_DataSet1\_Booms.xlsx)

## Slide 27

The final slide outlines another possible case study, in this instance using data on the amount of rubbish collected by Gross Pollutant Traps. There is a link to an Excel spreadsheet of the data (MI\_Coasts\_Activity3\_ShopShore\_DataSet2\_GPTs.xlsx)

# The investigation(s)

The data provided in the spreadsheets is a convenient means to lead to the mathematics, but it is Sydney-based. You may be able to substitute data from your local water authority.

# Extended investigation

Each of the three activities present opportunities for the school community to help protect their local waterway through a school action plan. A more comprehensive approach can be achieved by combining two, or even three, of the activities. It may be possible to include other year levels in the collection and analysis of the data.

# Resources needed

Projector to show PowerPoint

Access to the internet and Excel