

Investigating the maths inside:

Knowing nutrition

Information for teachers

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*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 showing the ways mathematics is used in real world applications.

# About this module

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This module consists of the video *Knowing nutrition* and the following activities:

Activity 1: 8700 kilojoules (Years 5 and 6, Year 11 Essential)

Activity 2: Clinical trials and bias (Year 8, Year 12 Essential)

Activity 3: Can snacks be good for you? (Years 7 and 8, Year 11 General)

# Feedback

Feedback from teachers about these classroom activities would be appreciated. Please complete the form at <http://tiny.cc/mathsinsidefeedback>.

# Background

Almost two in three Australian adults and one in four Australian children are overweight or obese. Excess weight, especially obesity, is a major risk factor for cardiovascular disease, type 2 diabetes, some musculoskeletal conditions and some cancers. As the level of excess weight increases, so does the risk of developing these conditions. In addition, being overweight can hamper the ability to control or manage chronic conditions.

Scientists are working to help people live healthier lives through diet and lifestyle programs, thus preventing illnesses, developing a better understanding of diseases, and improving treatment and recovery in a range of medical conditions.

Activity 1: 8700 kilojoules

Students understand that foods provide energy which is counted by kilojoules (or calories). They have background knowledge of the impact of additional weight or poor food choices on long-term health.

In this activity, students use online calculators to select a daily food plan that suits their requirements to maintain their current weight. They alter that plan to include some treats, then calculate the exercise that would need to be done to burn-off the kilojoules of the extra indulgences.

# Why do this?

This activity provides authentic links between mathematics and other subjects such as Personal Development, Health, Physical Education, Science and Food Technology.

It places basic arithmetic calculations and estimations into a relevant and realistic context.

# Australian Curriculum links

#### Year 5: Number and algebra – Number and place value

Use estimation and rounding to check the reasonableness of answers to calculations (ACMNA099)

Use efficient mental and written strategies and apply appropriate digital technologies to solve problems (ACMNA291)

#### Year 6: Number and algebra – Number and place value

Select and apply efficient mental and written strategies and appropriate digital technologies to solve problems involving all four operations with whole numbers (ACMNA123)

#### Year 11: Essential mathematics

Students use units of energy used for foods, including calories (ACMEM032)

Students use units of energy to describe the amount of energy in activity, such as kilojoules (ACMEM033)

# Getting started

A brief discussion of the two measures of energy (kilojoules and calories) may be a good starting point, as calories are commonly still used in Australia. A quick approximation is that there are 4 kJ in each calorie.

# Energy estimation

## The bacon-and-egg roll

Have a straw-poll about the number of kJ in a bacon-and-egg roll. List the highest and lowest estimates. Do the same for the amount of exercise time for both walking and running.

It is not expected that students have particularly accurate estimates. Record these estimates and return to them at the end of the activity.

One way of looking at the energy provided is to compare with the 8700 kJ daily total. For example, the 2200 kJ for a bacon-and-egg roll is 25% of the daily total!

Depending on weight, it could take almost two hours at a brisk walking pace or one hour running to burn-off that many kJ.

## Other take-away foods

There is a list of common take-away foods on the student activity sheet. They are to rank them from the food with the least kilojoules through to the one with the most kilojoules. Emphasise that they do not need to estimate the actual amount of kJ, just compare them. They should discuss their reasoning as they rank them.

Discuss as a class the rank orders and the reasons behind those rankings. Can the class come to any agreement?

Reveal the answers!

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Least kJ** |  | |  |  | |  | |  | | **Most kJ** |
| Tart (5)  614 | Sandwich (2)  1672 | Croissant (6)  1763 | | | Roll (3)  2194 | | Pie (7)  2304 | | Fish & chips (4)  2533 | Curry (2)  3237 |

Discuss the various reasonings used. Were there many misconceptions?

Factors that might not have been considered could have included portion size, additional ingredients (did the sandwich have butter?), preparation (was the egg fried or poached?) etc.

Tell the students the actual kJ count for the bacon-and-egg roll. Who was closest?

# Your food plan

In all discussions, there needs to be sensitivity to any issues about healthy weights.

## A food diary (optional)

Ask students to keep a food diary for a week prior to starting this activity. They should include all meals and snacks. They need to make detailed notes about the food and the quantity (in grams) consumed.

This can be a time-consuming task if kept diligently. As an alternative, you could ask students to record food consumption for a typical school day and a typical weekend day, and them combine them proportionally.

This activity can be done without having kept a food diary. However, if a food diary is not used, students need to get a ‘feel’ for the kilojoule counts of their favourite, or most commonly eaten, foods by using one of the suggested websites.

### Some useful tools

A downloadable paper version:

[www.healthyfoodguide.com.au/sites/default/files/Weekly-food-diary.pdf](http://www.healthyfoodguide.com.au/sites/default/files/Weekly-food-diary.pdf)

A cost-free downloadable app for Apple users:

<https://easydietdiary.com/>

A highly recommended tracker:

[www.myfitnesspal.com/](http://www.myfitnesspal.com/)

## How many kilojoules for you?

Typically, children will have a higher kilojoule allowance than an adult of similar weight.

Activity levels can have a significant impact. The class will need to decide what “moderately active” and “very active” mean. A logical exploration of changing the variables and recording the number of kilojoules with each change will make for a more useful discussion.

## A maintenance plan

The class will need to decide how closely the food plan kilojoule count should match the targeted kilojoule count. There needs to be a sensible leeway or too much time could be spent tinkering to get it exactly right.

At this point, a discussion on what constitutes a healthy or balanced diet, is appropriate. What should be omitted or swapped?

Students could experiment with different options to see if they make much difference. For example, what is the effect of swapping butter for margarine, drinking water instead of juice, replacing ice cream with low fat yoghurt.

## A plan with ‘treats’

The assumption is being made that treats will be more calorific than usual foods, although this is not necessarily true.

## Burning off extra kilojoules

There can be a few surprises here! For example, you would need to walk six kilometres to ‘walk off’ a McDonald’s Egg McMuffin. At a moderate pace, that would take an hour.

## Analysis

Students can compare plans and discuss findings.

You may wish them to work in groups to produce some advice based on their investigations.

# Resources

Access to the internet

# Further ideas

How do scientists calculate the energy levels of foods?

What is the mathematical relationship between kilojoules and calories? Which countries use which measure?

How did nutritionists arrive at the daily total of 8700 kJ for the average Australian? What assumptions are being made about the ‘average Australian’? What assumptions might have been made about the types of foods included in the 8700 kJ total?

Are all calories equal? Could you live on 8700 kJ of chocolate per day? If you were vegan, how much would you have to eat?

Activity 2: Clinical trials and bias

Students understand that clinical trials testing medical interventions must be carefully designed to eliminate bias and to give reliable results, and that there are many ethical considerations.

In this activity, a PowerPoint provides the prompts for classroom or small-group discussion. Students also do simple activities to demonstrate the variability of data and the process of randomisation.

This activity leads into Activity 3 where students analyse actual data from a real trial.

# Why do this?

This activity provides discussion points about eliminating bias in clinical trials to achieve reliable results. It places investigative statistical design into a relevant and realistic context.

The activity also considers ethical issues involved in conducting medical trials on human beings.

There are opportunities for cross-curriculum links to history (investigating the devastating effects of pandemics) and to science (the creation of vaccines and other medical interventions).

# Australian Curriculum links

#### 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 12: Essential mathematics: Data collection

Understand the purpose of sampling to provide an estimate of population values when a census is not used (ACMEM129)

Investigate the possible misrepresentation of the results of a survey due to misunderstanding the procedure, or misunderstanding the reliability of generalising the survey findings to the entire population (ACMEM136)

#### General capabilities

Ethical understanding, Critical and creative thinking

# Getting started

It is best to start with a discussion of a disease or other medical issue that might interest your class.

A good place to begin is the topic of vaccinations. Many diseases have been eradicated totally (e.g. smallpox) but other diseases still occur (e.g. malaria). These diseases had, and still have, a devastating effect on the populations subject to them.

A more modern example is Meningococcal Disease which is rare but can be deadly. It typically occurs in babies, teenagers and young adults. Most strains now have effective vaccines.

How do scientists test the vaccines? Once animal testing has been conducted (often over many years), scientists are allowed to conduct trials on human beings.

# Slide notes

These notes also appear under the slides.

## Slide 2: Clinical trials

Discuss the importance of clinical trials.

What are some types of interventions? For example: drugs, vaccines, surgery, medical devices, lifestyle changes, screening tests, psychological counselling, education.

What is meant by the term ‘side effects’? (Unintended consequences). Some examples could be nausea, headaches, weight gain, sleeplessness, irritability. Students may have personal knowledge.

## Slide 3

This slide outlines the rest of the PowerPoint issues covered.

## Slide 4: Ethics

What is ‘informed consent’? [Permission granted in full knowledge of the possible consequences i.e. both risks and benefits.]

Why is personal information confidential?

What kind of a trial might be unethical? What about ‘Super Size Me’? In this ‘experiment’ Morgan Spurlock eats nothing but McDonald’s for a month, puts on 11.1 kg and suffers a number of averse medical effects. This is the link for Wikipedia: https://en.wikipedia.org/wiki/Super\_Size\_Me

You could also watch the documentary on YouTube, although it goes for 1 hour and 40 minutes: https://www.youtube.com/watch?v=Sgcc\_ZZnAgM

## Slides 5–6: The trial protocol

Trials have to be safe! What can go wrong? Two students in the UK were left fighting for their lives after accidentally being given the equivalent of 300 cups of coffee instead of three! Cause was mismeasurement.

Link to one version of the reporting: https://www.telegraph.co.uk/news/2017/01/25/university-fined-400k-students-taking-part-caffeine-experiment/

## Slide 7–11: Control groups

What is a control group? Why is it important? Discuss.

What is a placebo? It comes from the Latin “I will please”.

If the treatment is a drug in pill form, the placebo is a pill that looks exactly the same as the new treatment, but contains no active ingredients (sometimes called a ‘sugar pill’).

Why might the placebo effect be a problem?

## Slide 12–14: Number of participants

Includes an activity on variability, an important statistical concept.

Each student tosses a coin 10 times. Record the number of tails and the number of heads. What was the largest number of heads? What was the smallest? What was the most common number of heads?

Combine all the students results. How many tails and how many heads? What percentage were heads and what percentage were tails?

Try the experiment again, this time adding the first set of class results with the second. Was there any difference?

Students should now understand that there can be a large variability with a small number of trials, which could lead to an erroneous result. Refer to individuals coin toss results at this point. If the desired outcome was ‘heads’, which student’s trial was ‘successful’ in the activity? How did that differ from the combined data results? Were they approaching the expected outcome of 50/50?

You may want to use a computer simulation to trial many, many tosses. This link takes you to a spreadsheet from AAMT’s Top Drawer Teachers’ website: http://topdrawer.aamt.edu.au/Statistics/Downloads/Coin-tossing-activity

## Slide 15–16: Randomisation

Includes an activity on randomisation.

Compare two mathematics classes, your class and another at the same year level. Do they have similar characteristics? In a junior class, you could consider gender, feeder primary schools, perhaps ethnicity. Would the two classes be similar enough to conduct an unbiased trial about mathematics?

What if you considered your class and a senior class? How different are they (if at all)?

## Slide 17: Blinding

Why might researchers prefer to use a double-blind process? What kind of bias might be eliminated by doing this? [Researches may unconsciously signal to participants how the research is going and their particular progress through comments or even body language.]

## Slide 18: Who conducts clinical trials?

Information.

## Slide 19: Funding

Information.

# Resources

PowerPoint (MI\_Nutrition\_Activity2\_ClinicalTrial.pptx)

Fair coins (enough for one for each student)

Access to the internet

# Next steps

These discussion points and activities lead directly into Activity 3.

# Further ideas

This activity provides a strong link to history. Students could investigate the devastation wrought by common diseases in the past (The Black Death) or more recently (The Spanish Flu’ Pandemic).

Students might be able to research some examples of funding for trials which might be expected to have bias e.g. tobacco companies and their ‘research’ into the effects of smoking.

Activity 3: Can snacks be good for you?

In this activity, students work with a large set of real data from CSIRO. They have to make decisions on how to organise the data in order to analyse whether the intervention of a specially designed snack has been successful or not.

Their results must be critically supported with statistics.

# Why do this?

Students understand the significance of the impact of diabetes on both individuals and the country as a whole, and the need for effective interventions to reduce the incidence of the disease. They are aware that life-style changes are one way of reducing the incidence of Type 2 diabetes.

The large data set is presented in a spreadsheet; students need to use basic skills to organise the data.

Students need to develop an argument about the effectiveness of the intervention, using statistics for support.

# Australian Curriculum links

#### Year 7: Statistics and probability - Data representation and interpretation

Investigate techniques for collecting data, including census, sampling and observation [(ACMSP284)](http://www.scootle.edu.au/ec/search?accContentId=ACMSP284)

Explore the practicalities and implications of obtaining data through sampling using a variety of investigative processes [(ACMSP206)](http://www.scootle.edu.au/ec/search?accContentId=ACMSP206)

#### Year 8: 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)](http://www.scootle.edu.au/ec/search?accContentId=ACMSP228)

#### Year 11: General mathematics: Data collection

Implement the statistical investigation process to answer questions that involve comparing the data for a numerical variable across two or more groups; for example, are Year 11 students the fittest in the school? (ACMGM033)

# Getting started

Begin by having a discussion about diabetes and finding out what students already know about this.

Read and discuss the summary *Reading: Glucose, insulin and diabetes*. Students do not need to understand the details of the biological processes; rather the concept that eating carefully and maintaining a healthy weight is a way to manage Type 2 diabetes.

You will probably need to explain some of the information, such as the units mmol/L and mg/dL.

The spreadsheet provided has information from 200 participants. Depending upon the students’ backgrounds, it may be necessary to teach or revise ways of sorting the data. They need to be able to group and sort the changes in glucose levels that occur.

# The clinical trial

Students should have done Activity2 *Clinical trials and bias* before they begin this activity.

Make sure they are aware of the need for all trials to have a large enough group of participants for the results to be reliable, as well as the need to have some sort of comparison either involving a placebo or a standard item to compare against.

This particular set of data does not measure up well to everything that is raised in Activity 2, however, it could qualify as a pre-trial to gather information to see if it is worth going to a full-scale trial.

If you wish, you could do a more detailed examination between the two groups, for example:

* Are there similar numbers of males and females?
* What proportion met the recommended guidelines for activity?
* Are the age profiles similar?

# The data

Examine the raw data. Make sure that students understand the various headings. The variables are explained on the second tab of the spreadsheet.

What was the trial about? What has been measured? Which parts of the data are important?

# Analysing the data

Ask students what the first step should be. They should respond that the first thing to do is to separate the participants into two groups: those that were given Snack 1 and those that were given Snack 2.

At this point, we are interested in finding out the change in glucose levels only. Students should insert a column to subtract the initial glucose level from the final glucose level.

Normal glucose levels vary between 4.0 and 7.8 mmol/L. Note that 7.8 is used as the upper level (instead of 6.0) because the participants were not given any information in regard to when they should eat the snack, that is before or after eating other food. This may have affected the results.

Students need to determine the broad categories of changes in glucose levels to decide whether the snack worked. A cell colouring scheme may be the best way to do this. Suggested groupings are provided in the second spreadsheet.

# Answers

#### Units

mmol/L is an abbreviation for millimoles/Litre. Molar concentration is the international method to measure the concentration of a solute in a solution.

mg/dL is an abbreviation for milligrams/deciliter. A decilitre is one tenth of a litre or 100 millilitres. This unit is used in the USA and Germany, plus some other countries.

#### Effectiveness of the snacks

Both snacks have some benefits for some users, however Snack 2 has better results and only has one participant whose glucose level goes up significantly.

Snack 1 has a greater number of participants whose glucose levels go up significantly, so the results could be described as ‘mixed’.

Snack 2 has slightly more participants whose glucose reduces from high to normal or stays at normal. However, it also has a larger number of participants (seven compared to two) whose glucose goes from the normal range to being too low. Students should include a proviso that those with glucose levels that are already normal should not be included in the trial, as Snack 2 generally reduces glucose levels even though they are normal to begin with.

Snack 2 also has greater potential to reduce glucose as 76 of the 100 participants had a reduction whereas for Snack 1, 50 decreased and 50 increased.

#### Full scale trial

A full-scale trial could have 200 plus participants taking Snack 2 and 200 plus taking a placebo. Snack 1 is probably not the best comparison or placebo to use as there were such mixed results for glucose level changes in the pre-trial. This number of participants is arbitrary, but students should at least comment that the trial is large enough to make reliable statements in relation to the numbers who have glucose levels returning to normal levels after eating the snack.

Participants chosen should have high glucose levels to begin with as six participants with normal glucose levels dropped to low when they ate Snack 2, which is not a desirable outcome.

Instructions should be given about when to eat the snack during the trial and instructions should also be given about eating before glucose levels are measured.

# Further ideas

If you wish, you could do a more detailed examination between the two groups, for example:

* Are there similar numbers of males and females?
* What proportion met the recommended guidelines for activity?
* Are the age profiles similar?

Further analysis, using the numerical data for insulin could be undertaken.

* Are there similar changes?
* Is there a correlation between improvement in glucose levels and improvement in insulin levels?

# Resources

Download: *Reading: Glucose, insulin and diabetes* (MI\_Nutrition\_Activity3\_Snacks\_Reading.docx)

Unsorted raw data (MI\_Nutrition\_Activity3\_Snacks.xlxs)

Possible answers (MI\_Nutrition\_Activity3\_Snacks\_SortedCodedData)