Maths Modelling Challenge: Years 7 - 12

Teacher Handout

Scenario: School Run

The start and end of the school day is a well-recognised time of increased congestion on our roads. The majority of school run pick-up and drop-off is by car, leading to an increase in traffic and driver frustration, particularly around school zones, as well as an increase to safety concern, noise pollution and air pollution.

Local Councils are looking at ways to reduce the impact of the school run. A viable alternative is to encourage more students to cycle to school. Cycling has numerous benefits, including reduction of car congestion, noise pollution and air pollution. Cycling also provides daily exercise which has been proven to improve physical health and mental wellbeing.

The local Councils and schools have decided to partner and are planning to start a month-long initiative "Cycle to School" at the beginning of the next school year. Your group has been asked to help the Councils measure the environmental impact of the proposed initiative at your school over the full school year.

There are many ways to approach this problem but a good place to start is to consider the number of students in your school, the average distance they are travelling from and the amount of fuel needed to drive these students to school every day.

Key points the Councils have asked you to address are:

- How much fuel is used to do the school run for your school every year?
- What is the associated carbon footprint of these yearly car journeys?
- How would this figure change if 20% of students who go to school by car decided to participate in the Cycle to School month and then 5% went on to take this up for the whole year?

Maths Modelling Challenge: Years 7 - 12

Teacher Handout

Scenario: School Run

Useful Resources

There are many ways to approach this problem and many sources for reference. Below is a list of useful links and hints that provide some background reading and may aid in your approach to the problem. These can all be access without special licenses to journals.

A great link that explains why cycling to school is good for you and the environment.
https://bq.org.au/resources/why-ride-to-school/

Video link of Daniel O'Doherty, *2008 'Action Against Climate Change' Eureka Schools Prize winner*, as he determines his hypothesis then designs and conducts a study about carbon emissions. His simple formula may help you design your approach but there are many more factors that you can consider.
https://education.abc.net.au/home#!/media/29790/impact-of-coming-to-school-on-carbon-emissions

A great study on the social cost of carbon is given here.
https://doi.org/10.1038/s41558-018-0282-y

You may already know the number of students, catchment area and number of school days in a year but if not you can always ask your teacher. However, the following are some useful links to estimate catchment area and fuel consumption.

Catchment area

https://www.qgso.qld.gov.au/maps/edmap/

Fuel consumption

https://co2.myclimate.org/en/car_calculators/new

Index

Carbon absorption rate of trees: a process whereby carbon is removed from the atmosphere and stored long-term in trees, roots and soil.

Catchment area: is the area in which a state school's core intake of students must live.

Fuel consumption: is the amount of fuel used per unit distance travelled; for example, litres per 100 kilometres (L/100 km). This can be converted into CO_2 emissions using online calculators.

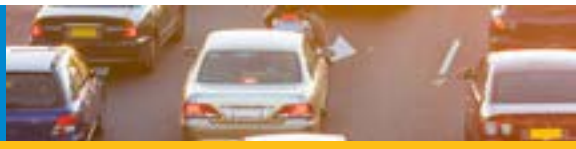
Greenhouse gas emission: the release of harmful gases into our environment from transport.

*Planetary health:*the health of human civilization and the natural systems, such as the environment, on which it depends.

Maths Modelling Challenge: Years 7 - 12

Teacher Handout

Scenario: School Run



Additional Notes for Teachers

All entries must be students' own work and verified on submission.Acceptable teacher support for students please refer to below *Footnotes - points of discussion and exploration.*

- Students will need to research the number of students at their school and the average size of the catchment area to evaluate the average distance driven per school run.
- Students will also need to model average fuel consumption of a typical family car on the Sunshine Coast.
- Students may also want to consider that:
  - students may have siblings at the same school
  - the students who sign up to partake in the Cycle to School initiative and then go on tocycle all year may live closer to the school than the average student.
- Encourage the students to put this into context, i.e. a flight from Brisbane to London = 3.75tCO2e. If this program went statewide (there are ~1800 schools in QLD) how many flights would we be saving?

Example Work Through

Average number of students per school = **s**

Assume 50% go to school by car **S = s/**2

Average number of children per family = 1.9*

Cars needed for school run = C = (S/1.9)

Number of school runs in a year = 200days x 2 trips

School catchment area = **A**km2. Model area as a circle, therefore, radius = **R**km, average distance driven to school modelled as ½ **R** km and assume the car is going back to the starting point** so each average school run = 2 x ½ **R**km = **R** km https://www.qgso.qld.gov.au/maps/edmap/

Total distance travelled for the school run each year = D = 400 x **C** x **R**km

Average fuel consumption for a family car in Australia = **f** = 10.8L/100km***

Fuel consumption for school run per year = F = D/100km x 10.8L

Carbon footprint **CF** = can be calculated from a number of websites including myclimate.org. enter in D, f and type of fuel**** to evaluate CO2 amount. https://co2.myclimate.org/en/car_calculators/new

Impact of Cycle to School month = $\mathbf{I_a}$ = (**CF**/12) x 0.2‡

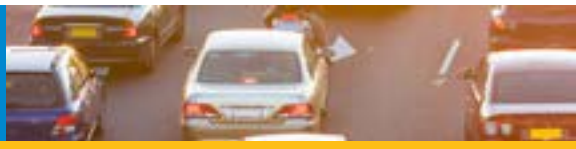
Impact of 5% continuing for the rest of the year = $\mathbf{I_b}$ = (**CF** x 11/12) x 0.05†

Total impact of Cycle to School initiative = $\mathbf{I_t}$ = (($\mathbf{I_a}$ + $\mathbf{I_b}$)/CF) x 100

Maths Modelling Challenge: Years 7 - 12

Teacher Handout

Scenario: School Run



Additional Notes for Teachers

Footnotes - Points of Discussion and Exploration

* This may or may not be modelled, but the students should then be asked to think about sources or error and over/under estimation.

** Students may wish to add in a constant for the percentage of school runs being done on the way to/from work. Furthermore, this over simplified R evaluation assumes an "all roads lead to school" setup. Students may wish to model a more comprehensive definition of average route length.

*** Students may want to take in to account fuel consumption changes with speed. School runs are often done in suburban areas with lower speed limits. These rates can be found online.

**** Students may wish to model different fuel types – the most common for a family car is petrol. These percentages can be found online from the 2019 census data.

‡ This assumes that school runs are spread evenly throughout the year which is obviously not true for the summer holidays. Students may wish to discuss this in their presentations as a source of error.

† Students may want to consider and discuss the fact that students who sign up to partake in the Cycle to School initiative and then go on to cycle all year are more likely to live closer to theschool than the average student.

USC STEM programs are designed to inspire the next generation of leaders in Science, Technology, Engineering and Mathematics. Underpinned by the ethos that STEM has applications across the curriculum and beyond the classroom, all activities challenge students to use STEM in solving every day, real-life problems. W: MIELab.edu.au E: MIEEvents@usc.edu.au

School of Science, Technology and Engineering and School of Education and Tertiary Access. MIE Events is funded by the Australian Government Department of Education and Training under the Higher Education Participation and Partnership Program.