Role-play: 'Planning engineers' pose and solve 'big number' problems

Key Learning Area	Unit or lesson title and main focus questions	Most appropriate level and suggested number of lessons
Geography	**Role-play: 'Planning engineers' pose and solve 'big number' problems** How will the innovative approach to train travel used on Sydney Metro Northwest improve public transport conditions for commuters?	Stage 2–3
Mathematics		1–2 lessons

Teacher briefing

Students role-play 'planning engineers' and learn about the tasks these experts perform in the construction of new railways. They create imaginative 'big number' problems (only a few of which they may be able to solve). Students appreciate how mathematics is used in everyday life, and how Sydney Metro Northwest will improve public transport in their local community.

Sample problems

Sydney Metro Northwest is 23 kilometre long including 15 kilometre twin tunnels between Bella Vista and Epping. What percentage of the journey is in the tunnel?

If the journey time for Sydney Metro Northwest is 37 minutes for a route length of 35.25 kilometre with trains stopping at 11 intermediate stations for 30 seconds per station (excludes Cudgegong Road and Chatswood), calculate the average train speed.

Requirements for these lessons

- Interactive whiteboard and Internet access
- Computers, laptops and Microsoft PowerPoint software
- Hard copies of articles and images or iPads.

Assessment

Peer assessment activities included. As this is a large group activity, students may also benefit from self-assessment questions. For example:

- How well did I work in a group?
- What are three ways in which I contributed to the group project?
- How could I have contributed better to the way the group worked?

Key terms and vocabulary

Sydney Metro Northwest, planning engineer, innovative approach, big number problems.

Web links

Description of the role and responsibilities of a planning engineer

http://www.myjobsearch.com/careers/planning-engineer.html

Sydney Metro Northwest website – project map

https://www.sydneymetro.info/map/interactive-map

Sydney Metro Northwest Environmental Impact Statement 2

https://www.sydneymetro.info/sites/default/files/01_Cover__Declaration__Exec_Summary__ToC.pdf%3Fext%3D.pdf

Syllabus links

Mathematics K–10

(MA2–17MG) uses simple maps and grids to represent position and follow routes, including using compass directions

(MA3–17MG) locates and describes position on maps using a grid-reference system

(MA2–1WM) uses appropriate terminology to describe, and symbols to represent, mathematical ideas

(MA3–1WM) describes and represents mathematical situations in a variety of ways using mathematical terminology and some conventions

(MA2–2WM) selects and uses appropriate mental or written strategies, or technology, to solve problems

(MA3–2WM) selects and applies appropriate problem-solving strategies, including the use of digital technologies, in undertaking investigations

(MA2–13MG) reads and records time in one-minute intervals and converts between hours, minutes and seconds

(MA3–13MG) uses 24-hour time and am and pm notation in real-life situations, and constructs timelines

(MA2–6NA) uses mental and informal written strategies for multiplication and division

(MA3–6NA) selects and applies appropriate strategies for multiplication and division, and applies the order of operations to calculations involving more than one operation.

Geography K–10

Stage 3– Factors that shape places– humans shape places

(GE3–1) describes the diverse features and characteristics of places and environments

(GE3–2) explains interactions and connections between people, places and environment

(GE3–4) acquires, processes and communicates geographical information using geographical tools for inquiry.

Learning experiences

Step 1 – Class discussion

Teacher introduces the role and responsibilities of a planning engineer using the website My Job Search.com. (See web links).

The class discusses the following questions:

- What is an engineer?
- What is a planning engineer? What might be some of the roles and responsibilities of Sydney Metro Northwest planning engineers?
- Why are engineers involved in rail projects?
- How do planning engineers assist large-scale civil construction work?
- What could be some of the questions planning engineers might need to solve in their daily work in a project like Sydney Metro Northwest?

Teacher poses the focus question to the class – How will the innovative approach to train travel used on Sydney Metro Northwest improve public transport conditions for passengers? Teacher led class discussion follows.

A mind map of students' ideas is created and saved on the interactive whiteboard. Ask students to keep this question in mind as they develop their 'big number' railway problems.

Step 2 – Class activity

Teacher displays a Sydney Metro Northwest map, and asks map interpretation and mathematical questions. This is intended to demonstrate how maps can be used to create 'big number' problems and to model problem solving strategies.

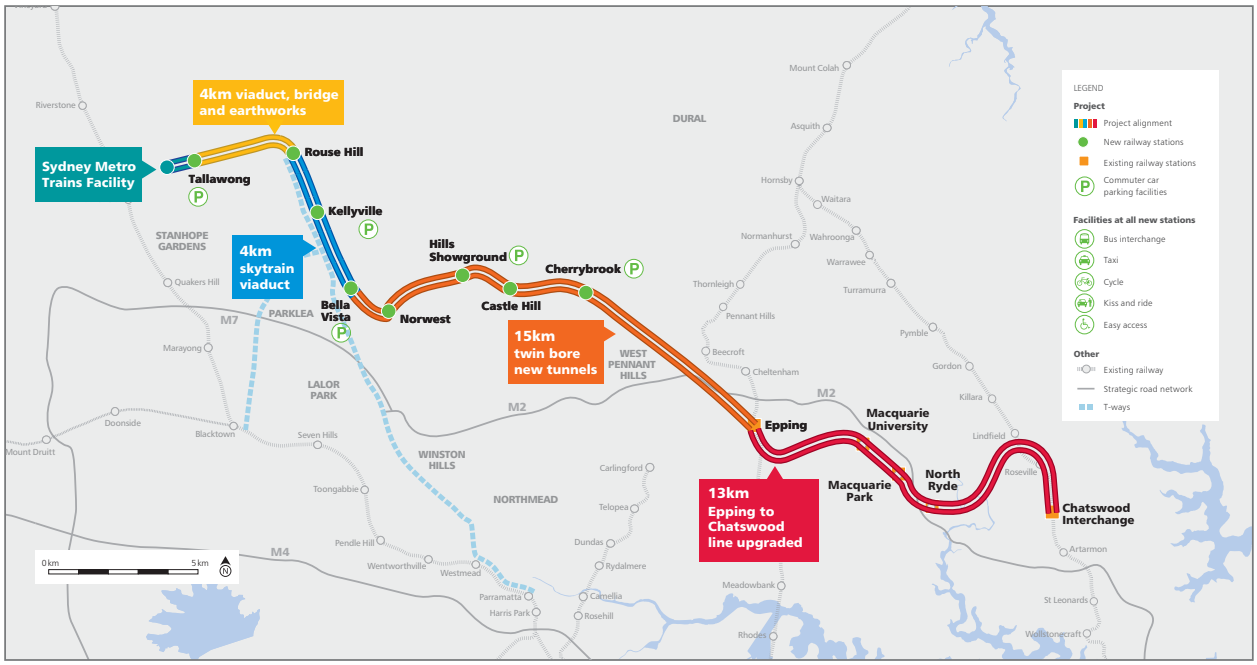

Figure 8: Sydney Metro Northwest planning engineers look at the 'big picture' and must solve many 'big number' mathematical problems to ensure that everything will work as the project progresses.

Suggestions for map interpretation:

- What stations already exist?
- Which are the new stations?
- How do you know?
- What is the legend on a map used to identify?
- What is the scale on a map used to identify?
- What is the total length of the Sydney Metro Northwest railway line? How could you find out? How would you know if you had the correct answer?

This is a suggested mathematical question to explore as a class:

If the journey time for Sydney Metro Northwest is 37 minutes for a route length of 35.25 kilometres with trains stopping at 11 intermediate stations for 30 seconds per station (excludes Cudgegong Road and Chatswood), calculate the average train speed.

Working out:
Actual travelling time 31.5 minutes (taking out 30 seconds for each stop)
Over 35.25 kilometres this averages out to 1.12 kilometres per minute
Multiplied by 60 minutes

Answer: An average speed of 67.14 kilometres per hour

Step 3 – Group activity

Planning engineers at work!

Split the class into two teams. In each team there are small working groups of three to four students.

In their role as planning engineers, students work in teams to create a series of 'big number' Sydney Metro Northwest problems for other groups to solve. It is at the discretion of the teacher how many mathematical questions each group creates.

Group 1 is given Sydney Metro Northwest *Project Overview*, September 2015 (pages 8, 10–13). The group is to use statements and quotes such as, "no timetable required – turn up and go", "15 trains per hour in the peak" and their own ideas and questioning strategies to create a series of 'big number' Sydney Metro Northwest mathematical problems.

https://www.sydneymetro.info/sites/default/files/15082-Project-overview-September-2015_web.pdf%3Fext%3D.pdf

The group is to use statements and quotes such as, "no timetable required – turn up and go", "12 trains per hour in the peak" and their own ideas and questioning strategies to create a series of 'big number' Sydney Metro Northwest mathematical problems.

Group 2 is given Sydney Metro Northwest *Environmental Impact Statement 2* Executive Summary. The group is to use statements and quotes such as "4 kilometres of skytrain between Bella Vista and Rouse Hill" and "Single deck trains carry approximately 50% more people per hour than double deck carriages" and their own ideas and questioning strategies to create a series of 'big number' mathematical problems.

The mathematical questions can range widely. Some starter examples the teacher may like to 'seed' the group discussion:

- Sydney Metro Northwest is 23 kilometres long, including 15 kilometre twin tunnels between Bella Vista and Epping. What percentage of the journey is in the tunnel?
- From 2006 to 2036, The Hills Shire's population is forecast to increase by 57% over the thirty year period. In 2006 it was 165,000. What will it be in 2036?

Step 4 – Group activity (working in the same two groups)

In their role as planning engineers, groups swap 'big number' problems and work as a team to attempt to solve the problems.

Using solved problems, groups work as a team to create a PowerPoint presentation answering the question – How will the innovative approach to train travel used in the Sydney Metro Northwest improve public transport conditions for passengers?

Step 5 – Reflection

Set the scene for a Sydney Metro Northwest planning meeting simulation. During the planning meeting, group representatives present their PowerPoint presentations to the class and students peer assess the presentations.

'Think Pair Share' activity – students find a partner and have two minutes each to share their opinions of the presentations with one another. The questions:

- Was the presentation effective? Why or why not?
- What, if any, points could have been added to the presentations?

'Two Stars and a Wish' activity – students split back into two groups and decide on two excellent aspects of the presentation they assessed and one wish that would improve the presentation.

The questions:

- What are the best two aspects of the presentation?
- What is one wish for the presentation?

Teacher references and extension work

Stage modifications: Stage 1

This learning experience could be used with Stage 1 students by implementing it over several weeks. This would allow students to link mathematical problems to real life situations, develop working mathematical strategies using position and number outcomes, and discuss some of the features of Sydney Metro Northwest.

Teacher identifies and labels aspects of the Sydney Metro Northwest project map on the interactive whiteboard before asking basic positioning questions.

Teacher demonstrates by posing several basic mathematical questions and solving them using the Sydney Metro Northwest map.

Students, with the assistance of the teacher, work in small groups towards posing a mathematical question using simple addition and subtraction operations and/or multiplication and division strategies. For example, if 12 trains stop at Cherrybrook Station every hour, how often would they stop?

Extension activities

Students work individually to create and then solve a series of 'big number' Sydney Metro Northwest problems using the 'Strategic Context' page of the Sydney Metro Northwest *Project Overview* June 2012, page 8.

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