Linear Relationships 1 – Coordinate Geometry – Year 9

YEAR: 9	CLASS:	TEACHER:	DURATION: 3 weeks (5 hrs)

TRANSFER GOAL(S):

To develop a positive self-concept as users of mathematics, obtain enjoyment from mathematics, and be able to respond to familiar and unfamiliar situations by employing strategies to make informed decisions and solve problems relevant to everyday life.

THE BIG IDEA

Linear relationships are very common in mathematics and science. The graph of two quantities that have a linear relationship is a straight line. A linear relationship may be a direct relationship or an inverse relationship. In a direct relationship, as one quantity increases, the other quantity also increases, or as one quantity decreases, the other quantity also decreases. In an inverse relationship, as one quantity increases, the other quantity decreases. Examples of linear relationships familiar in everyday life include the distance travelled and time taken, the conversion of one currency to another, the cost of printing involving an initial set-up cost and a dollar rate per item, the cost of taxi fares involving a hiring charge and a dollar rate per kilometre, and the cost of catering involving a base amount for a set number of people plus a rate for each extra attendee. Coordinate geometry facilitates the exploration and interpretation of linear relationships.

SYLLABUS OUTCOMES:

MA0-WM-01 develops understanding and fluency in mathematics through exploring and connecting mathematical concepts, choosing and applying mathematical techniques to solve problems, and communicating their thinking and reasoning coherently and clearly

MA5-LIN-C-01 determines the midpoint, gradient and length of an interval, and graphs linear relationships, with and without digital tools

MA5-LIN-C-02 graphs and interprets linear relationships using the gradient/slope-intercept form

ENDURING UNDERSTANDING

Students will understand that……

all linear relationships are represented by straight line graphs. We can interpret these linear relationships to find the midpoint, gradient and distance between two points on that line, as well as finding where they cut each axis on the Cartesian Plane.

ESSENTIAL QUESTIONS

How do we measure the slope of a line?

How can we find the distance between two points?

What are some methods that we can use to sketch linear relationships?

Why are there intercepts when we graph lines?

How do we determine if two lines are parallel?

KNOWLEDGE

Students will know:

- The length of an interval.
- The midpoint of an interval.
- The gradient of a line.
- How to graph linear equations.
- How to identify x- and y-intercepts.
- To interpret and graph linear relationships using y=mx + c.
- Whether a point lies on a line.
- That parallel lines have equal gradients.

SKILLS

- Determine the midpoint of horizontal and vertical intervals on the Cartesian plane
- Apply the process for calculating the mean to find the midpoint, of the interval joining 2 points on the Cartesian plane
- Use graphing applications to find the midpoint and gradient/slope of an interval
- Determine the midpoint of horizontal and vertical intervals on the Cartesian plane
- Calculate the distance between 2 points on the number plane.
- Construct a table of values and use this table to construct a graph.
- Use a variety of methods to graph linear functions.
- Determine if two lines are parallel.

Key Inquiry Questions	How do we measure the slope and midpoint of a line? How can we find the distance between two points? What are some methods that we can use to sketch linear relationships?
Driving Question	**How can we apply coordinate geometry to a real-world situation?**
Learning Across the Curriculum	• Critical and creative thinking • Information and communication technology • Literacy • Numeracy
Authentic Group Roles	Students will work in groups in Lesson 3.
Authentic Audience	Sydney Metro
Entry Event	Students use Sydney Metro website to identify ‘Maths in the Real World’
End Product/s	Proposal to Sydney Metro Board about Metro Line Extension.

Learning Strategies/workshops	Resources
Entry Event: Provide students with the opportunity to examine the Sydney Metro website and brochure. In groups, get students to brainstorm/list questions of inquiry that may arise. Provide opportunities for students to collaboratively share these as a class and discuss. Using SSTs from Year 9 Geometry mathematics, get students to identify applications of maths in the 'real world'. Share examples as a class and discuss. Provide students with a hard copy map of the Sydney Metro network, overlaid with a Cartesian Plane from DESMOS. Challenge students to find the coordinates of 4 Metro stations, one from each quadrant and record. Provide students with the opportunity to share their coordinates and have other students identify where on the Sydney Metro network these coordinates are located. Once students have found 4 Metro station coordinates, provide them with the opportunity to use Desmos to overlay a Metro Interactive Map themselves. Students to create a mind map of the application of mathematics they used to understand the Sydney Metro in today's lesson.	Sydney Metro: 360 camera walk through new metro train www.sydneymetro.info Sydney Metro Brochure SSTs Math in the Real World Map: https://drive.google.com/file/d/1viL0rk0T3A_T-wUZwcvrEZdVwQYwfCPr/view?usp=sharing Workshop: Quadrants of the Cartesian Plane Metro Interactive Map WORKSHOP: How to use Desmos to overlay IBT: Application of Mathematical Concepts

Learning Strategies/workshops	Resources
Discuss the launch question from the Unit of Work: *We have explored graphical ways of finding the Midpoint, Gradient and Distance, but do we always need to graph our lines to find these values? Or is there another way we can calculate them?* Using the overlay map and scale of the Sydney Metro lines, determine the distance between 2 stations. Units will be in km. Review Pythagoras' Theorem for finding the hypotenuse of a right-angled triangle. Students use coordinate geometry to calculate the distance between their chosen stations: ▪ Students use Pythagoras' theorem or derive the formula for finding the distance between two points. ▪ In pairs, students demonstrate how to use either strategy to find the distance between two points. ▪ Students describe how the distance between (or the length of the interval joining) two points can be calculated using Pythagoras' theorem. ▪ Students then use the interval between two points on the Cartesian plane as the hypotenuse of a right-angled triangle and apply Pythagoras' theorem to determine the length of the interval joining the two points (i.e., 'the distance between the two points') Students will be provided/asked to calculate straight line distances between their chosen stations. Students will break each distance between stations into smaller intervals and add to find total distance. Students compare the distance calculated using the scale with the distance found using coordinate geometry (Pythagoras/formula).	Map: https://drive.google.com/file/d/1viL0rk0T3A_T-wUZwcvrEZdVwQYwfCPr/view?usp=sharing Sydney Metro Map.png Metro Interactive Map Sydney Metro Timetable: Chatswood to Tallawong Timetable: https://drive.google.com/file/d/133VR3d-OFaqSY-x7od3rVnBlMHEB4wvn/view?usp=sharing

Students calculate the time taken to travel between their chosen 2 stations. Students will convert times to a measurement in hours. Provide students with a copy of the timetable (pdf of Chatswood to Tallawong) Students calculate the speed of the Metro between their chosen 2 stations using their calculations for distance and time. Students calculate the slope (gradient) between their chosen 2 stations. Students reflect on the launch question again and respond: We have explored graphical ways of finding the Midpoint, Gradient and Distance, but do we always need to graph our lines to find these values? Or is there another way we can calculate them? Give evidence for your answer. Provide opportunities for students to collaboratively discuss their thinking as a class.	

Learning Strategies/workshops	Resources
In groups of 2-4: 1. Students select one proposed Sydney Metro line on the map. Use the process for calculating the 'mean' to find the midpoint, M, of the interval joining two stations on a Metro/Cartesian plane overlay. 2. Students explain how the concept of mean ('average') is used to calculate the midpoint of an interval. 3. Students use the map of Sydney Metro to explore places that the network does not reach. 4. Students select an area for the location of a new Metro station beyond the current/proposed network using Google Earth and the Sydney Metro Map by extending the Metro line in that direction. Provide students with the opportunity to discuss the impacts (+/-) of their proposed 'new' Metro line. 5. Using their mathematical reasoning, students need to calculate the distance and midpoint to their proposed destination. 6. Get students to annotate their map overlay with their proposed Metro station. Students to use Geometer's sketchpad or Autograph or GeoGebra to plot points, investigating midpoint and gradient. In their groups, provide students with the opportunity to convince (through a medium of their choice) Sydney Metro to extend the Metro line to their identified location.	Sydney Metro Map.png Metro Interactive Map Google Earth Map: https://drive.google.com/file/d/1viL0rk0T3A_T-wUZwcvrEZdVwQYwfCPr/view?usp=sharing Workshop: How to use Geometer's sketchpad Resources to help with Proposal Costs: https://themetrorailguy.com/metro-rail-systems/sydney-metro-information-route-map-fare-prices-pass-hours-timings/ Population: https://www.sydneymetro.info/sites/default/files/2021-09/Secondary_Teacher_Resource_Education_Book_Full_Edition.pdf