STARS RESOURCES

Teacher notes

How close together are the stars in constellations?

ACTIVITY

Recreate a constellation in your classroom and look at it from all angles.

Students will:

- recognise that the stars in constellations are very far away from each other
- explore the mathematical and geometric concept of ‘perspective’
- identify the Southern Cross and name the stars
- use a telescope to view the Southern Cross constellation in the night sky (optional)

This activity is aimed at Years 5-8.

There are two options supplied here, to allow differentiation for those students who may struggle with the large-scale activity.

CURRICULUM LINKS

YEAR 5 MATHEMATICS V.9

Space

Describe and perform translations, reflections and rotations of shapes, using dynamic geometric software where appropriate; recognize what change and what remains the same, and identify any symmetries (AC9M5SP03)

- understanding and explaining that translations, rotations and reflections can change the position and orientation of a shape but not the shape or size
- demonstrating how different combinations of transformations can produce the same resulting image
- challenging classmates to select a combination of transformations to move from an original image to the final image, noting the different combinations by using different colours to trace images

CURRICULUM LINKS cont'd

YEAR 7 MATHEMATICS V.9

Space

Describe transformations of a set of points using coordinates in the Cartesian plane, translations and reflections on an axis, and rotations about a given point (AC9M7SP03)

- experimenting with, creating and recreating patterns using combinations of translations, reflections and rotations, using digital tools

YEAR 8 MATHEMATICS V.9

Space

Describe the position and location of objects in 3 dimensions in different ways, including using a three-dimensional coordinate system with the use of dynamic geometric software and other digital tools (AC9M8SP03)

BACKGROUND INFORMATION

Constellations

For many of us, constellations are our first introduction to the night sky. Interestingly, professional astronomers use the International Astronomical Union's list of 88 official constellations to indicate general areas of the sky.

This activity investigates the Southern Cross constellation. Read more about it: 'The Southern Cross – a star guide', ABC Local website, https://www.abc.net.au/local/stories/2014/01/23/3931015.htm (23 January 2014)

Stars of the Southern Cross

The Southern Cross can be seen nearly all year long from the southern hemisphere. The four main stars are Alpha, Beta, Gamma and Delta Crucis (where 'Crucis' refers to the cross shape). Each of the stars is 10 to 20 million years old.

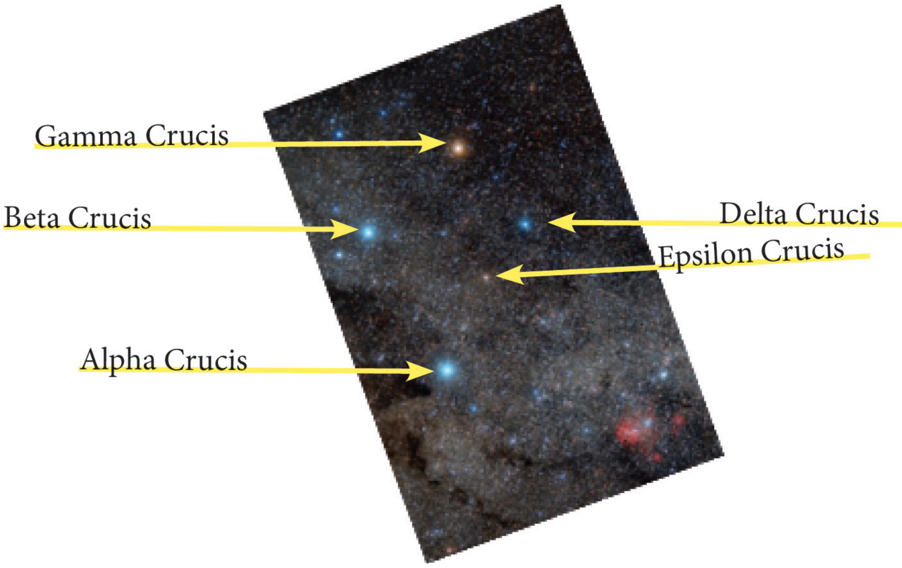
From this angle, it looks like all of the stars have been placed on a flat sheet in that pattern, and one may be mistaken for thinking they're all related to one another. Scientists have analysed each of them and found that this is not the case. They were not born together, they have never been close to each other, and they are so far apart from one another that their gravitational pull on each other is too small to be of any importance.

To the naked eye all of the stars in the Southern Cross appear to be essentially the same colour. However, as can be seen in the photo, they're all slightly different.

BACKGROUND INFORMATION cont'd

The difference comes from their temperature. The more blue a star, the hotter it is, and similarly, the more red a star is, the cooler it is.

**For the purposes of this activity, it is up to the teachers' discretion whether or not the colour of stars is explored.



Spatial reasoning

Every generation in recent times has been slowly losing its spatial reasoning capabilities. This is partially through dependence on digital technologies such as GPS devices, instead of using old-fashioned maps (to read more, 'Habitual use of GPS negatively impacts spatial memory during self-guided navigation', Nature.com, https://www.nature.com/articles/s41598-020-62877-0, 14 April 2020), and a move away from traditional toys like building blocks.

This activity will:

- explore spatial reasoning, covering spatial orientation and spatial visualisation, and can be extended to cover mental rotation and translations of shapes. Read more about these skills for students in lower secondary school, 'Measurement of spatial ability: Construction and validation of the spatial reasoning instrument for middle school students', Journal of Psychoeducational Assessment, 35(7), 709 – 727. https://journals.sagepub.com/doi/10.1177/0734282916659207
- model a real example of spatial orientation and geometric perspective.

Consideration of prior knowledge

It is likely that students in upper primary and lower secondary classes are aware of the stars on the Australian flag. Some students may also be aware that the Southern Cross appears on the New Zealand, Samoan, Brazilian and Papua New Guinean national flags. Before beginning the activity, consider spending time discussing constellations (including other commonly known ones such as Orion the Hunter and the Pleiades).

BACKGROUND cont'd

In addition, revise 2D and 3D shapes; rotations and translations of shapes; viewing of objects from different angles; estimation of scale, size and distance of common objects such as cars. Suggested resource: 'Angles, 2D shapes and 3D objects – I3', ID: 2PZJDS, FUSE website, https://fuse.education.vic.gov.au/ResourcePackage/ByPin?pin=2PZJDS.

Also consider activities that make students more conscious of some basic geometric concepts in their everyday world.

Suggestions include[1]:

a. Have a student stand four paces in front of the teacher. With their arm extended, can the student 'cover' the teacher's face with a fingertip? Do they need to step forward or backward to perfectly cover the face?

b. Take a piece of cardboard and cut a round hole two centimetres across in it. How must the cardboard be held relative to the student's face and where must the student stand in order to see a chosen picture on the wall? Change the angles and distances amongst the cardboard, face and picture and optimise the conditions.

c. Find a place at the top of a building or on a balcony with a view below of vehicles or playground equipment. How long are the objects down below relative to a student's little finger?

d. Imagine standing on a railroad or tram/light rail track. The tracks seem to join far away.

e. Watch a bird in the sky from the playground. In which direction is that bird flying? How do you know?

f. Watch an aircraft flying overhead. Question why it is (apparently) going so slowly?

g. Pose the question: Which is bigger, the Sun or the Moon?

h. Pose the question: Does the Moon follow us about?

i. Use a doll's house or look into the classroom from the playground. What can the students see in a room when looking in from the outside?

j. Use a torch to explore where shadows come from.

k. Extend (j) to investigate the shapes of shadows from different shaped-objects.

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1 Adapted from Lange Jwn, Jan de (1986). 'Geometry in the primary school: what is possible and desirable', in Robert Morris (ed.) Studies in mathematics education. France, UNESCO, p61. https://unesdoc.unesco.org/ark:/48223/pf0000068216.locale=en

BACKGROUND cont'd

This snippet from the BBC comedy, Father Ted, may be used as a springboard for discussion: 'Small and Far Away!', YouTube, https://youtu.be/OXypyrutq_M (23 seconds).

Here is a suggested, scaffolded activity on forced perspective from the Royal Air Force Museum in the UK ('Forced perspective', https://www.rafmuseum.org.uk/documents/Cosford/Educational-Visits/Online_Resources/FamilyResources/RAFMForcedPerspective.pdf).

Using the telescope

If you wish to look at the Southern Cross in the sky using a telescope, watch these tutorials.

'How to set up a Dobsonian Telescope', ASTRO 3D YouTube (5:37 mins), https://youtu.be/pvb-_WqNkPQ (31 March 2020)

'Tools and Accessories for a Dobsonian Telescope', ASTRO 3D YouTube (11:06 mins), https://youtu.be/M7kDzUK7ZHE (31 March 2020)

ACTIVITY - OPTION 1

Human Southern Cross

Equipment

- 5 students to be 'stars' and 5 people to be helpers (minimum)
- Balloons – 1 red, 3 blue, 1 orange (choosing these colours isn't essential, but it is recommended that the alternative option is to use 5 balloons all of the SAME colour to reduce misconceptions)
- Camera (optional)
- Paper/pen/clipboard for each student
- 5 x metre rulers
- A large room, such as a hall, or the oval

ACTIVITY - OPTION 1 cont'd

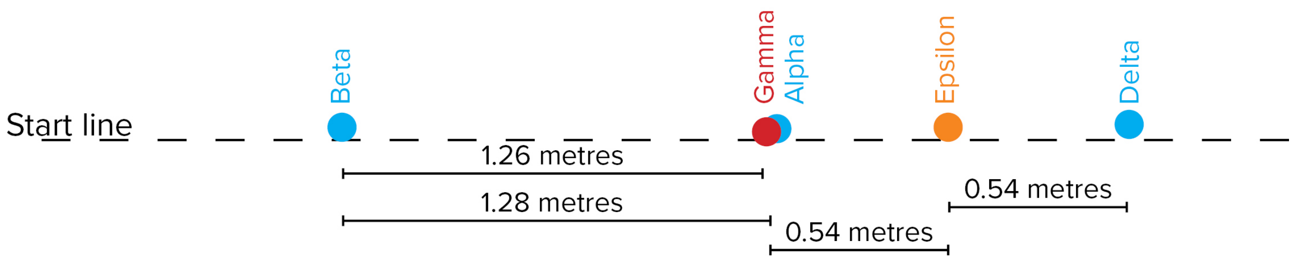
Planning ahead

Before the session, consider following these steps to mark out where your 'stars' will stand in order to create a constellation.

1. Along one end of the oval or hall, draw a line about three metres long. In the middle of this line, mark out a spot to represent Earth's position. Imagine the far wall or far end of the oval is the night sky.

2. Measure out distances along this line for each of the stars, as shown in the diagram.

Bird's eye view

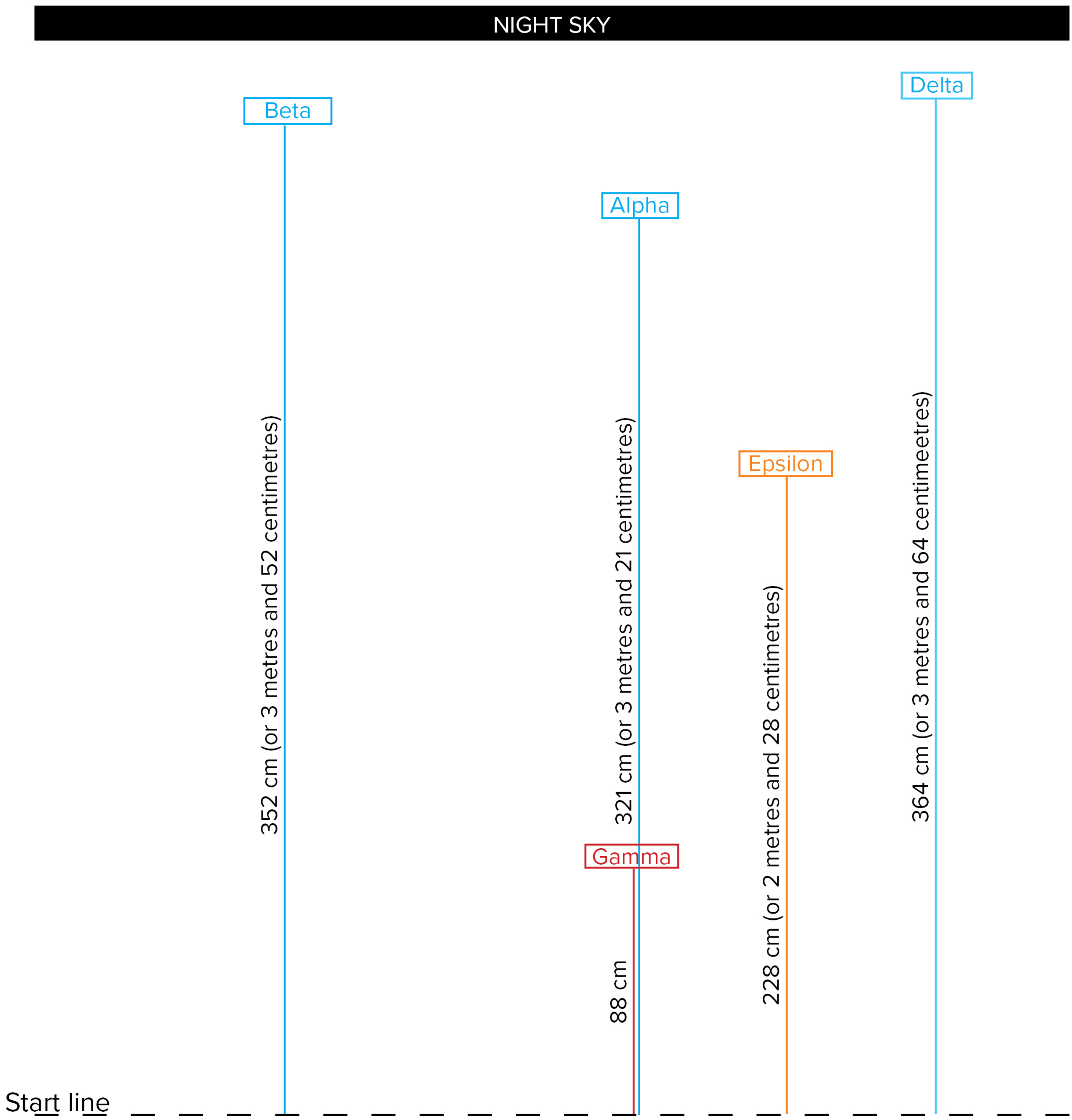


3. Measure out distances for each of the stars, beginning at the start line and heading towards the 'night sky'.

Alpha crucis	321 cm (or 3 metres and 21 centimetres)
Beta crucis	352 cm (or 3 metres and 52 centimetres)
Gamma crucis	88 cm
Delta crucis	364 cm (or 3 metres and 64 centimetres)
Epsilon crucis	228 cm (or 2 metres and 28 centimetres)

ACTIVITY - OPTION 1 cont'd

Bird's eye view



ACTIVITY - OPTION 1 cont'd

Activity

1. Allocate five students to be the five 'stars'. Each 'star' takes a balloon of the correct colour (unless all of the balloons are the same colour).

Alpha crucis	blue
Beta crucis	blue
Gamma crucis	red
Delta crucis	blue
Epsilon crucis	orange

2. Allocate five students to be helpers for the stars and give each of them a metre ruler.

3. Have each star take up position on their allocated mark (i.e. Beta crucis stands 352 cm away from the starting line) and turn to face the start line. Each 'star' is now the correct distance to-scale away from the Earth.

4. Have each helper join a 'star' and measure the correct vertical height for their balloons, starting at the ground, according to the following table.

Star	**Height**
Alpha crucis	on the ground
Beta crucis	99cm above ground
Gamma crucis	165cm above ground
Delta crucis	115 cm above ground
Epsilon crucis	71 cm above ground

5. Each star raises their balloon to their allocated height. Use the middle of the balloon for the measurement of the height.

6. Time to look at the Southern Cross constellation. Have the rest of the class gather at the starting line and look towards the 'night sky' and sketch or photograph what they see.

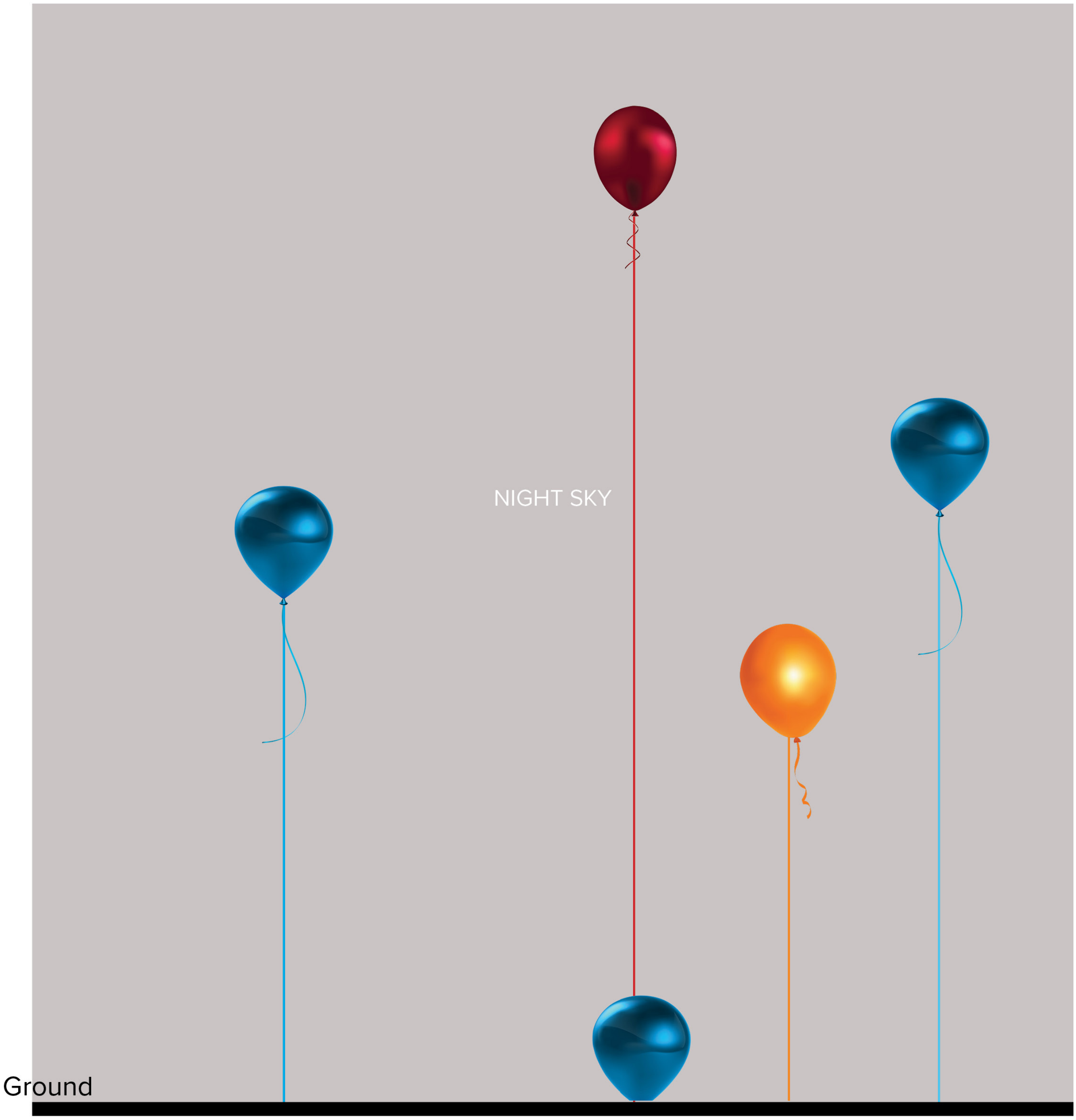
7. Now ask each of the stars to turn 90 degrees to their right, while still holding their balloons, and have the rest of the class walk around to face them from approximately the same distance away from Beta as in step 6. Repeat the sketch or photograph.

8. Discuss with the class how to label the diagram to show where they're standing compared with the starting point (e.g. 90 degrees clockwise, 180 degrees from starting position, against the wall with the windows, etc.)

9. Repeat steps 7 and 8 two more times. The stars can rest their arms in between, as necessary.

ACTIVITY - OPTION 1 cont'd

Front view



ACTIVITY - OPTION 2

Southern Cross mobile

Equipment

- A4-sized cardboard box (printer paper box lid is ideal) **OR** A4 sized piece of strong card **OR** an old-fashioned over-head projector transparency sheet (or similar) and permanent black marker. Use the printout as a guide to draw the positions of the stars onto the transparency
- a print out of the Southern Cross as it appears on the sky (supplied overleaf)
- glue stick
- string
- scissors
- 5 small pom-poms or aluminium foil rolled into 5 balls
- sticky tape
- 30 cm ruler

Activity

1. Glue the picture of the Southern Cross to the lid of the box, or use the transparency. The orientation of the image doesn't matter. The flat plane of the picture represents the surface of the Earth.

2. In the middle of each star, poke a hole through the picture and the lid.

3. Starting with Alpha star, have the students measure a piece of string to the length indicated in the table below and add two centimetres. Cut.

4. Tape a pom-pom to one end of the string, or crunch a small square of foil onto the end of the string.

5. Poke the free end of the string upwards through the hole labelled as Alpha. Leave one centimetre poking out and use sticky tape to secure the string.

6. Continue with all of the stars.

ACTIVITY - OPTION 2 cont'd

Alpha	6.5 cm
Beta	7 cm
Gamma	17.5 cm
Delta	7 cm
Epsilon	4.5 cm

7. Students should hold up their mobiles so that the strings all hang down. The view of the mobile from side-on is what would be seen from out in space somewhere far from Earth. If the overhead projector sheet was used, there is the added benefit of also looking down to see what the Southern Cross looks like from Earth.

SUGGESTED QUESTIONS

1. In this activity, the pom poms represent the stars. Do you think they're the right size to actually represent how big stars are compared to the distances you've measured? Why? Why not? *The stars are light years from Earth, and light years away from each other. A light year is 9.46 trillion kilometres. All stars are different sizes, but even the biggest ones are only about 1 billion kilometres across. Therefore, the diameter of a pom pom would have to be at least 1/1000th the length of the pieces of string. Space is big!*

Read to find out more: 'Distance between stars of the Southern Cross', Powerhouse Museum, https://www.maas.museum/observations/2008/05/19/distance-between-stars-of-the-southern-cross/, *(May 19 2008)*

2. What do you notice when you look at the constellation from different angles? Draw the constellation from a different angle. Can you think of an animal or story to tell about this new constellation by drawing a picture using the stars?

3. Do you think the constellation would look different if you were on the surface of Neptune?

Not likely. The distance difference between Earth and any of the solar system's planets is very small compared to how far away the other stars are. Also, the planets are all on the same plane for viewing the stars.

4. Imagine you're with someone who has never seen the Southern Cross in the sky before. How would you describe the constellation's shape and the stars that belong to it? E.g. Find the star that is ... go down and to the right a little bit and find another star that is...look for the stars in a kite shape...etc.

SUGGESTED QUESTIONS cont'd

5. Now you have an understanding of how things can appear to be close together when they're not, when looked at from certain angles. Where might you see this phenomenon in everyday life? *Cars in a carpark, play equipment in a park, trees in a forest, farm animals in a paddock, ducks on a pond, tables in a restaurant/café, cricketers on a cricket field.*

EXTENSION ACTIVITIES

'Stellar navigation and mathematics', University of Melbourne: Indigenous Knowledge Institute, https://indigenousknowledge.unimelb.edu.au/curriculum/resources/stellar-navigation-and-mathematics

Organise a star gazing night for the students to use a telescope and look more closely at the Southern Cross. https://astro3d.org.au/wp-content/uploads/2022/03/STARS-Star-gazing-night-Teacher-notes.pdf

FURTHER READING

Australian Curriculum website, https://australiancurriculum.edu.au/TeacherBackgroundInfo?id=16964

Australian Curriculum website, https://www.australiancurriculum.edu.au/TeacherBackgroundInfo?id=56653

Australian Curriculum website v.9 (year 6), https://v9.australiancurriculum.edu.au/teacher-resources/background-information/science_teacher_background_information_AC9S6U02_E6

Australian Curriculum website v.9 (year 10), https://v9.australiancurriculum.edu.au/teacher-resources/background-information/science_teacher_background_information_AC9S10U03_E5

'Navigation and Star Maps', Australian Indigenous Astronomy website, http://www.aboriginalastronomy.com.au/content/topics/starmaps/

'Southern Skies and Southern Cross – Sixty Symbols', Sixty Symbols YouTube channel (5:20 mins), https://youtu.be/LwZel_emm3Y (19 Nov 2011)

'Aboriginal Astronomy – Behind the News', Behind the News YouTube channel (3:18 mins), https://www.youtube.com/watch?v=Wv8hKMj6ikA, 25 Oct 2016

'About Constellations', Lunar and Planetary Institute/NASA website, https://www.lpi.usra.edu/education/skytellers/constellations/

(All websites accessed May 2023)

Teacher notes
How close together are the stars in constellations?