Connecting Indigenous Knowledges (IK) with mathematics curriculum

Supporting information for educators

stronger smarter

Mathematics Hub

Country and its resources: artist's statement

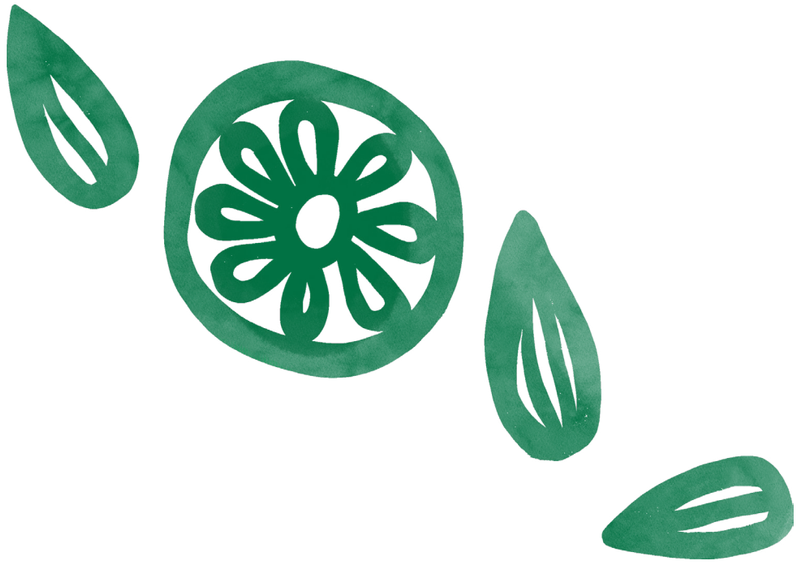
Resources and Country are intrinsically connected as is the need to come together and learn. Each element in this artwork is a reflection of the resource's movement and their natural shape. The organic nature of the shapes furthers the connection with the naturally occuring shapes of Country.

Cover artist Keisha Leon is an Aboriginal graphic designer and digital artist. She is a proud Waanyi-Kalkadoon (Mount Isa, Queensland) and Chinese woman. Keisha creates a visual story that is driven by culture and the modern world, connecting people, and helping create the narrative for the future.

Acknowledgement of Country

The authors and partners of this guide would like to acknowledge the Traditional Custodians and Elders across all Nations. We acknowledge your place as owners of the lands and waterways we work, teach and learn upon. We acknowledge the continuing cultures and connections to Country. We acknowledge ancestors as the First Mathematicians. We also pay our respects to our emerging Elders, our future leaders, our strong and smart students. They are the mathematicians of our future. We pay our respects to all Aboriginal and Torres Strait Islander peoples working within teaching and learning. We are confident that the information in this guide will be useful in supporting an understanding of the connections between mathematics and cultures.

Connecting Indigenous Knowledges



Overview

This Mathematics Translation Guide is intended to inspire teachers of mathematics to see the connections between mathematics and Aboriginal and Torres Strait Islander peoples, histories and cultures.

This guide supports the Indigenous Knowledges videos and posters while drawing on common themes across First Nations cultures. Indigenous Knowledges are shared so you can view mathematics content in different ways, based in real histories and cultures.

These Indigenous Knowledges could be the reality that you use in the Goompi or Cloud Model (Matthews, 2009) of Culturally Responsive Pedagogy. In the videos and posters, Indigenous Knowledge experts give examples of reality for mathematics teaching and learning.

This guide is not exhaustive. You should use these examples together with Indigenous Teaching Assistants and your local First Nations community to localise perspectives for place-based mathematics.

When you work within the Third Cultural Space alongside First Nations peoples, Indigenous Knowledges and mathematics knowledge become culturally responsive mathematics. That means you plan and deliver mathematics in culturally responsive ways while maintaining cultural and mathematical integrity. The Third Cultural Space is a place of sharing and deep listening to multiple perspectives. You can explore it more in the Third Cultural Space Guide.

This guide is background information on common knowledges across many First Nations communities. The videos and posters delve more deeply into specific knowledges from different parts of Country.

Cultural worldview

Matthews states “all knowledge is heavily grounded in a cultural worldview” (cited in Price, 2012, p. 101). He explains the cultural bias of mathematics from the perspective of the observer. In the Third Cultural Space Guide, Indigenous Knowledges videos and posters and this Mathematics Translation Guide, the observer’s reality comes from different First Nations perspectives.

In these resources, the cultural contexts of mathematics do not include sections based on the western classification system of number, algebra, measurement, geometry, statistics and probability. These resources instead include an Indigenous worldview of mathematics, which is holistic: a set of interwoven concepts, seen through patterns and cycles (Matthews, 2020) within the natural environment. This reflects the differences in worldviews and classification systems.

The Australian Curriculum Science Elaborations explains this perspective.

> *“Many living things are grouped by First Nations’ Australians based on their use. A vast knowledge exists around the use of living things when alive, such as fresh plant sap for medicines. However, equally important is the knowledge of what once living things can be used for. For example, many plants are grouped together based on their use when they are no longer living: spear trees, string trees, shield trees, canoe trees, resin trees and many other use-based categories. Living things are at times put into groups based on features such as form and function. These groupings are not always based on relatedness as used in the Linnaean classification system.”*
>
> (ACARA, 2019, pp. 28-29)

Matthews adds that classification of all living things was based on kinship systems to ensure relationships between people and all other elements of the earth. That means hierarchy, class, order and groupings differ between the First Nations’ and western classification systems.

> To see and understand an Indigenous perspective of mathematics you must accept the premise that mathematics is intrinsically connected to culture and consequently, has many different cultural expressions. (Matthews, 2019, p. 1)

Diversity in cultural worldviews includes the way we view mathematics within the natural environment and through connections to Country. The themes in the Third Cultural Space Guide, six Indigenous Knowledge videos and the posters all interconnect. When western mathematics and Indigenous Knowledges meet within the Third Cultural Space, there are natural links to the Australian Curriculum: Mathematics. These resources will support you to develop your personal understanding of local First Nations cultural contexts for learning.

Connections to Country/Place includes using natural resources in learning. These were the teaching and learning tools of the past. Today, using these materials facilitates mathematics content and pedagogy outdoors. This type of content and pedagogical approach can engage all learners of all cultural backgrounds.

Holistic planning and teaching of mathematics

Guided by Elders, Traditional Custodians and Indigenous Teaching Assistants, Indigenous Knowledges are shared from the perspectives of saltwater peoples (coastal communities) and freshwater peoples (inland communities).

Educators should consider the cultural wealth of community and recognise these knowledges as strengths to explore relationships. While using the Indigenous Knowledges videos and posters, you should collaborate with your own local community to enact the Third Cultural Space. This is a place of sharing and deep listening to multiple perspectives (see the Third Cultural Space Guide).

Equitable knowledge sharing in culturally safe spaces can support inclusion of multiple perspectives of mathematics. Within each of the six interconnected themes, learning and knowledges come from different perspectives. Each poster and video has multiple perspectives. You could see them as diverse knowledges coming together.

“Holistic models and concepts are based on Indigenous Ways of Knowing, Being and Doing” (Davis, 2017, p. 85). Professor Chris Matthews also asks teachers to consider mathematics as a holistic process. Mathematics should be viewed as part of an interconnected process of learning. This means that Indigenous Knowledges are at the forefront and represent the reality in the Goompi pedagogy of teaching and learning.

Indigenous Knowledges at the forefront

Indigenous Knowledges and connections to Country have informed successful teaching and learning for over 65,000 years. This is why these resources include Indigenous Knowledges from experts across the Country. These knowledges form the context for each of the six themes across the resources.

The interconnected themes throughout the accompanying video clips and posters are:

- Connections to Country/place
- Shells and other vessels
- Stone tools
- Fibre
- Food resources
- Fire

It is important to view these themes holistically.

> ***"These themes are deeply connected to each other in the ecological Knowledge systems of Indigenous Australians. Furthermore, humans and nature are interconnected. Human beings are seen as part of the ecosystems and cannot be fully grasped or managed if separated from it. This view is implicit in the Indigenous concept of Country...we aim to achieve a better understanding of the complex nature of the interconnectedness between humans and nature."***
> **(Adone & Bruck, 2019, p.1)**

When Indigenous Knowledges are at the forefront of teaching and learning, educators value cultural knowledges to embed the cross-curriculum priority of Aboriginal and Torres Strait Islander Peoples Histories and Cultures. Placing Indigenous Knowledges at the forefront of learning enables all students to become exposed to diverse histories, cultures and identities. Additionally, Indigenous students are empowered to see themselves, their own histories, cultures and identities reflected within curriculum content.

Figure 1. Indigenous Knowledges at the forefront, Stronger Smarter Institute.

You can see Figure 1 from different perspectives. It could be bolting Indigenous Knowledges on at the end or starting with Indigenous Knowledges.

When you put Indigenous Knowledges at the forefront of teaching and learning, you can draw on conceptual connections to mathematics. It sparks interest for First Nations students and they engage in learning.

All students must be exposed to Aboriginal and Torres Strait Islander histories and cultures as a cross-curriculum priority. Within each of the videos and posters, you can use each context for different stages of learning while meeting each stage in the Australian Curriculum: Mathematics.

Professor Chris Matthews: Goompi Model

The culturally responsive pedagogy in the videos and posters is Professor Chris Matthews' Goompi Model. Matthews' first mathematics education project was at Goompi (Dunwich) State School on Minjerribah (Stradbroke Island), Queensland. He said, "The model is called the Goompi Model because it is the traditional name of the Country Dunwich State School resides. The name keeps the connection back to Country: its place of origin."

The four steps in the Goompi Model are:

1. Reality
2. Abstraction
3. Mathematics
4. Reflection

Reality

This model begins with 'reality' of the observer. The Indigenous Knowledge contexts presented through posters and videos is the reality. These Indigenous Knowledge contexts are examples for you to view mathematics from a different cultural perspective. You must then work within the Third Cultural Space with your own local communities to learn local knowledge. Whole school communities working within the Third Cultural Space may find other ways for sharing mathematics teaching and learning with all students.

Abstraction

The next step in the Goompi Model is 'abstraction'. Mathematics is often shown as abstract content and processes, which students can see as appearing out of nowhere or something on the pages of a textbook or worksheets.

Professor Chris Matthews describes abstraction as what we go through to get to mathematics. It could be the creation of language symbols or drawings. Mathematics symbols are just another form of communication. Abstraction is how we talk about mathematics in our own way, relating it to our prior knowledge and experiences. It determines the meaning we attach to mathematics.

Mathematics

Using the videos and posters, mathematics is shared from the reality of Country. Indigenous Knowledge holders share mathematics from their own perspectives and how it can be viewed on Country.

Mathematics is inherent in Country by reading the land. Indigenous and western knowledges start to merge when you:

- listen to stories of Country
- learn how to read the land and start to view mathematics through a different cultural lens.

This is where you complement Indigenous Knowledges with your expert mathematics content knowledge. It allows you to draw conceptual connections. This process supports students to work from their cultural strengths and build their knowledge.

Reflection

Thinking about mathematics through a western lens may involve some personal critical reflection or discussion and reflection with others. This is another step where you should enact the Third Cultural Space in the process of the Goompi Model. Listening to other perspectives on mathematics can support you to see the reality of mathematics through a diverse cultural lens.

Professor Chris Matthews' previous work and literature describes the full context of the Goompi Model and expands on each of the four steps. This guide does not give a detailed description of Professor Chris Matthews' work. It does describe how reality informs the resources through Indigenous Knowledges.

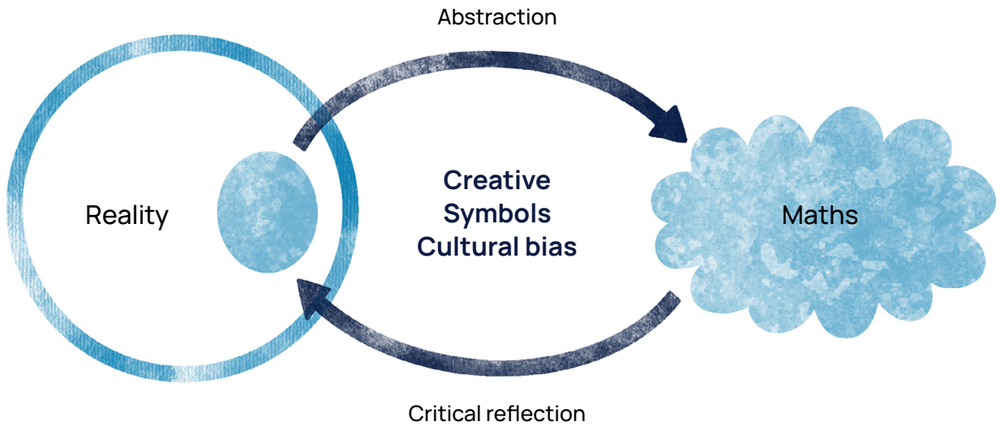


Figure 2. Goompi Model, Professor Chris Matthews, 2009, p. 47

Interconnections

> *"For Aboriginal and Torres Strait Islander peoples, maths is not always about quantities or numbers. Instead, it focuses on relationships of all kinds. It includes relationships between the range of elements of the known physical and socio-cultural environment."*
> **– Nurragunnawali**

Each of the posters and videos link to other cultural contexts for learning. Understanding interconnections will support you to address multiple curriculum requirements. These are examples of interconnected mathematics knowledges across the themes.

In theme 1, Connections to Country and Place, the videos and posters include knowledges that influence all other posters and videos. Connections to Country/ Place is at the centre, with all knowledges stemming from this core.

Throughout theme 1, navigation, direction and location are represented through:

- knowledges of the sea mullet migration north along the east coast of Australia
- mutton birds returning to Tasmania
- turtles returning to the same birthing place (Mon Repos, Bundaberg).

This informs knowledges within many other contexts. First Nations people's knowledge of Country and listening to Country for seasonal indicators enabled navigation to find food sources.

There are also interconnections in these areas:

- Theme 2 (Shells and other vessels) and theme 4 (Fibre) interconnect where trochus and maireener shells are used as body decoration.
- Theme 2 incorporates knowledges of theme 6 (Fire), where hot ashes were part of cleaning and polishing shells for body decoration.

These interconnections are examples of how Indigenous Knowledges are interconnected and holistic.

Figure 3 shows links of holistic knowledges of mathematics.

Figure 3. Holistic Knowledges of Mathematics

Weaving connections between Indigenous Knowledges and mathematics

Experts share knowledge on each of the six themes in the Indigenous Knowledges videos. Use the examples in the posters to tailor mathematics experiences to suit your local situation and community.

You can use these examples as a guide to weave connections between Indigenous Knowledges and mathematics aligned to the Australian Curriculum Version 9: Mathematics.

Connections to Country/Place

Connections to Country and Place include rich and deep knowledge of the landscape and natural environment, waterways, navigation, direction and location. It includes traditional or historical methods of remembering pathways and travel routes using songlines. It also shows how listening to Country and observing the changing seasons guided travel. This theme shows how sustainability and land management has been enacted for thousands of generations.

Songlines trace earth and sky elements from ancient stories and describe how these things have helped to shape the landscape. They were first used by First Nations people to communicate across the continent and to map Country. Songlines chart the landscape of Australia, but they are complex and do not always follow a linear direction.

Navigating through and across country

- Knowledge of the stars and constellations as passed down through Dreaming stories
- Pathways for travel
- Song lines
- Observations of the night sky supported the predictions of weather and recurring weather patterns

Seasonal changes

- Seasonal indicators within the natural environment including movement of animals. One example is observing sea eagles' behaviour on Stradbroke Island to predict the time of the sea mullet migration.
- Observation of changes on Country including changes with plant growth also supported the knowledge of seasonal cycles.
- Recording of changes in the environment including land, sea and sky occurred through artwork which can be viewed through rock paintings and on artefacts today.
- Bunya nut harvest is more plentiful every three years.
- Indigenous seasonal calendars and the differences between these and western calendars.

Traditional gatherings

- Distances travelled at certain times of the year to attend ceremony (Bunya Harvest, shellfish and ceremony season of Yolngu Peoples, yolla (mutton-birds) and swan rookeries in Tasmania or trading routes travelled).
- Body decoration according to place including feathers, shells, teeth, ornaments, face paint, and body paint.
- Cultural exchanges occurred through trading useful or significant environmental objects between clans forming trade routes.

Land management

- Only taking the number of resources you need from Country, leading to sustainable practices.
- Having a purpose and use for each part taken (kangaroo sinew used for string)
- Planting and harvesting techniques.

Indigenous Knowledges	Connecting Indigenous Knowledges and Mathematics	Connections to the Australian Curriculum
Matt Burns (Quandamooka Traditional Custodian from North Stradbroke Island) shares his knowledge of seasonal and environmental indicators on Quandamooka Country. Migration of parrots and sea mullet indicates winter (cold weather) is coming. Sea eagles sing out twice a day to indicate that the tides are soon to change. Changes in the wattle tree flowers guide when and where to fish on the island.	**Share Indigenous Knowledge about seasonal and environmental indicators** Students build a body of knowledge of seasonal indicators in the local area as they: – draw their ideas of the seasonal and environmental indicators – explore seasonal indicators in the natural environment including changes to plant and animal behaviours – compare the duration of natural events such as flower blooms and animal behaviours such as bird nesting – create a timeline of a year divided into months and add images or photos of local environmental indicators – use the timeline to discuss event duration (how long they last) or time (when in the year they occur).	In Year 1, students: – compare directly and indirectly – order events based on duration and explain their reasoning – investigate where First Nations peoples estimate, compare and communicate measurements, for example, the duration of seasons (AC9M1M01) – describe the duration and order of events using years, months, weeks, days and hours – investigate durations of time shown in First Nations seasonal calendars (AC9M1M03). In Year 3, students do statistical investigations with guidance. They collect, represent and interpret data, showing differences in numbers and categories to respond to questions of interest. This could include investigating First Nations seasonal calendars where they collect data and: – make frequency tables and spreadsheets based on environmental indicators – create one-to-one data displays about frequency of environmental indicators for the current season (AC9M3ST03).

Indigenous Knowledges	Connecting Indigenous Knowledges and Mathematics	Connections to the Australian Curriculum
Bart Pigram (Yawuru man from Broome) shares how he uses his knowledge of the Yawuru Country landscape to navigate on well-travelled cultural tracks.	**Share Indigenous Knowledge about navigating through Country** Students: – draw a map as if it were in the sand/soil – identify, find and map parts of Country – describe routes to and from landmarks – reflect on drawing a map and justify their use and positions of landmarks.	In Year 3, students: – interpret and re-create – in 2 dimensions – familiar environments, showing landmarks and objects relative to each other – explore land maps or cultural maps First Nations people would use to identify and find important landmarks such as waterholes (AC9M3SP02). In Year 4, students use grid references and directions to: – find and describe positions and pathways – make their own grid reference systems (AC9M4SP02).
Bart Pigram (Yawuru man from Broome) shares how he uses his knowledge of the Yawuru Country landscape to navigate on well-travelled cultural tracks.	**Share Indigenous Knowledge about distances to navigate through Country** Students: – draw what they know about the ways First Nations people travelled through Country – estimate and calculate the distances travelled – discuss the use of scale to describe distances – reflect on distances calculated and justify their use of metric measurements.	In Year 6, students: – convert between common metric units of length – choose and use decimal places in metric measurements relevant to a problem – explore distances travelled by First Nations people (AC9M6M01).
Jason Smith (Palawa man from Lutruwita) shares his knowledge of the changes in the environment including land, sea and sky on Palawa Country.	**Share Indigenous Knowledge about environmental indicators** Students: – draw environmental indicators, such as winds, observed on Country – investigate local weather and wind patterns through estimating and measuring wind direction, speed and intensity and describing its effect on the environment – discuss the use of scale to describe wind intensity – reflect on the scale they used to describe wind intensity.	In Year 8, students: – investigate ways to collect data, including experiment and observation – explain how to get data and implications with these techniques – use digital tools or experiment with ways to collect data to measure wind intensity using a relevant scale (AC9M8ST01).

Shells & other vessels

Shells and other vessels were used and modified using processes of design, technology and engineering. They were used in food and water gathering and were/are often decorated with art to share stories. The contents of shells were used as a source of food and evidence can be found in the shell middens located around the country. Shells and other vessels can be used in the measurement strand of mathematics as well as in all areas of STEM.

Design, Technology and Engineering

- Bailer shells were a useful vessel for transporting ochre (Watson, 2016).
- Types of shells used, how they were made into other usable objects, spearheads
- Water holding vessels including possum skin water carriers, palm tree frond vessels and coolamons
- How vessels were found, made, modified, and used
- Different types of trees were used for airtight watercraft through gum, sap and beeswax that was used for glue or sealing gaps or holes,
- Conch shells were used as a wind instrument
- Hollow logs, dugout or bark canoes

Story sharing

- Engravings in pearl shells may represent water or lightening as well as tell stories about First Peoples experiences.
- Another form of shell, eggshell was also used as the basis for carving or engraving stories. Hollowed out emu eggs were artistically carved to share stories, and song lines across country.

Measurement

- One emu egg is equal to around 10 chicken eggs and this knowledge can be utilised in contemporary Mathematics teaching of ratio, multiplication and division.
- The use of shells varied according to their size and shape. Educators can explore different types of vessels used and calculate the mass they will hold.
- Area and volume of shields and coolamons from size of scar on scarred tree.
- Cavities in branches of eucalyptus trees hold water.
- Bivalve shells including clam, oyster, pippy and mussel shells open in two halves (Yirka, 2019) which can support teaching of symmetry.

Food gathering and preparation

- Cooking vessels.
- Shell middens from oyster, cockle, whelk shells and pippy shells.
- Shellfish and seafood
- Egg shells
- Coolamon uses

Body ornaments

- Trochus and Maireener shells were highly valued due to their pearly iridescent nature. They were used for body ornaments during ceremony and initiation. These shells were counted to form repeating patterns in necklace design (Greeno, 2016).
- Oyster or pearl shells were also used for ornamental purposes. Pearl shells were used for trading and making necklace as body decoration.

Indigenous knowledges	Connecting Indigenous Knowledges and Mathematics	Connections to the Australian Curriculum
Matt Burns (Quandamooka Traditional Custodian from North Stradbroke Island) shares his knowledge of coolamons: a traditional carrying vessel used on Quandamooka country. Coolamons are made from bark carved from trees. They are used for gathering, preparing and serving food, holding babies, ochre, and carrying a fire torch.	**Share Indigenous Knowledge of traditional carrying vessels** Students: – draw the shape of the Coolamon and how it is carved from tree trunks – compare and use informal units to measure the amount of liquid or solid carried in a variety of traditional vessels – compare and order vessels according to amount held or mass – justify their reasoning for ordering different vessels.	In Year 1, students: – compare directly and indirectly – order events using attributes of duration, communicating their reasoning. They could investigate times where First Nations people estimate, compare and communicate measurements, for example, the capacity of traditional carrying vessels (AC9M1M01). In Year 2, students measure and compare objects based on length, capacity and mass using uniform informal units and smaller units for accuracy when needed (AC9M2M01).
Jason Smith (Palawa man from Lutruwita) shares his knowledge of the marineerer shells for body decoration and traditional necklace design made by the Palawa women. Jason relates the health of Country to the diversity of shells available on Country.	**Share Indigenous Knowledge of shells used for decoration** Students: – draw the shapes of shells Jason presented – use objects observed on Country to continue and create repeating patterns – draw a pattern for a traditional necklace and describe the repeating pattern used in their design.	In Year 1, students: – recognise, continue and create repeating patterns with numbers, symbols, shapes and objects, identifying the repeating unit – consider how making traditional shell or seed necklaces includes sorting shells and beads based on colour, size and shape, and creating a repeating pattern sequence (AC9M3SP02).
Bart Pigram (Yawuru man from Broome) shares his knowledge of using pearl shells for body decoration and their value for Yawuru people in trading. He discusses the pearl shell as a commodity which First Nations people traded. He shares knowledge of well-travelled trade routes across Country.	**Share Indigenous Knowledge of pearl shells used for trading** Students: – draw a picture of trading pearl shells for another resource found on Country – recognise trading of natural resources by First Nations people as a form of economy and alternative to using coins or money – role play trading natural resources – explore land maps or cultural maps to find traditional trade routes – explain and justify the bartering/trading system they designed.	In Year 3, students: – recognise the relationships between dollars and cents and represent money values in different ways (AC9M3M06) – interpret and re-create – in 2 dimensions – familiar environments, locating key landmarks and objects relative to each other – explore land maps or cultural maps used by First Nations people to identify and find important landmarks such as waterholes (AC9M3SP02).

Indigenous knowledges	Connecting Indigenous Knowledges and Mathematics	Connections to the Australian Curriculum
Bart Pigram (Yawuru man from Broome) shares his knowledge of the molluscs on Yawuru Country. He discusses the cockle, an edible marine bivalve mollusc that has 2 symmetrical shells.	**Share Indigenous Knowledge of molluscs found on Country** Students: – draw the lines of symmetry of shells shown by Bart – recognise line symmetry using objects observed on Country such as shells – represent the results of their findings indicating the line of symmetry – identify objects with symmetry and those that are not symmetrical.	In Year 4, students: – recognise line and rotational symmetry of shapes – create symmetrical patterns and pictures, using dynamic geometric software where appropriate – explore the natural environment on Country to investigate and discuss patterns and symmetry of shapes and objects such as in shells, flowers, plants and landscapes (AC9M4SP03).
Jason Smith (Palawa man from Lutruwita) shares his knowledge of bull kelp (a type of seaweed), used to design and make water-carrying vessels on Palawa Country. He acknowledges this is the traditional role of women. Jason relates the health of Country to the abundance of kelp.	**Share Indigenous Knowledge of kelp: a type of seaweed** Students: – draw the kelp and describe its properties – investigate using different materials to design and make a water carrying vessel – create an object by designing the net of the object – explain how they made the net.	In Year 5, students: – connect objects to their nets – build objects from their nets using spatial and geometric reasoning. – They could investigate objects designed and developed by First Nations people (AC9M5SP01).
Bart Pigram (Yawuru man from Broome) shares his knowledge of the middens on Yawuru Country created over thousands of years. He draws attention to the midden which is the largest in Broome, WA. Matt Burns (Quandamooka Traditional Custodian from North Stradbroke Island) shares his knowledge of middens on Quandamooka country. Matt describes the types of shells found and talks about the passage of time.	**Share Indigenous Knowledge of middens created over time of shells left over from eaten shellfish** Students: – draw a midden based on Bart's description of how it was created – model ways to estimate the number of shells that create a midden – share models and give feedback on each other's model, including how well it mathematically models the process of a midden's development and size over time.	In Year 9, students use mathematical modelling to: – solve practical problems (including financial) involving direct proportion, rates, ratio and scale – formulate the problems and interpret solutions in terms of the situation – evaluate the model and report methods and findings (AC9M9M05).

Stone tools

This poster incorporates Indigenous Knowledges through sharing the significance of stones and rocks for Indigenous Peoples. Stones were used in tool making, for hunting purposes, in food preparation, in trade and in story sharing.

Hunting

- Explore the types of rocks and stones that were chosen to use for different purposes
- Spear heads and barbs
- Cutting implements, axes, chisels, knives
- Sharpening of tools (grinding stones) different methods for making stone tools
- Stone fish trap and stone sinkers for shell fishing hooks
- Stone weights

Food preparation

- Identifying the correct rocks to add to kup murri for cooking (Warlayi in Kunnanurra Language, Adone et al, 2019, p. 93)
- Stone tools of flat rocks and grinding stones for processing food and medicine

Story sharing

- The location of ochre deposits,
- Ochre for body decoration during dance and ceremony
- Rock art, painting, and engraving
- Marking significant events in time
- Patterns of ochre body painting

Economy and trade

- Small stones and rocks were utilised for trading (a mathematical process) and to gain access to other parts of Country. Yuraal, is a Gamilaraay/Yuwaaliyaay word from north-western NSW, meaning small rocks. Yuraal represented an economy of trading between clans.
- transport of ochre
- Ochre is a culturally significant mineral. In traditional /historical communities, the trading of ochre occurred, and it represented a cultural economy. Different coloured ochre was mined on different parts of Country and was exchanged across different nations. Trading can be represented through Mathematics games.

Educators are asked to consider this knowledge from their own local perspective. For example, the traditional name for the Gympie Pyramid made from stone blocks is Djaki Kundu (Kabi language). Within the Third Cultural Space, educators could reflect on the processes that may have been utilised when building these pyramids. This may include different forms of measurement, lifting mass, and location.

Utilising the Third Cultural Space, teachers and Indigenous Peoples can use two-way teaching and learning to enquire into the local Peoples' patterns of painting for ceremony. Each diverse community has different patterns and symbols for body painting. The world of Aboriginal ritual and ceremony is a constant source for Aboriginal artists when choosing subject matter for their art and paintings. When preparing for ceremonies it is usual for the dancers to be painted up with ritual designs, using ochre colours on to the dancer's body. These designs can represent clan identity or totemic associations connected with the ceremony that is being conducted.

What is the probability you will find a triangle shaped pebble amongst a group of 20 pebbles?

Indigenous Knowledges	Connecting Indigenous Knowledges and Mathematics	Connections to the Australian Curriculum
Jason Smith (Palawa man from Lutruwita) shares his knowledge of the natural resources on Palawa Country, such as rocks and stones used as tools for crushing, grinding and cutting. Matt Burns (Quandamooka Traditional Custodian from North Stradbroke Island) shares his knowledge of stone tools. He describes the features of stone that are used for different purposes.	**Share Indigenous Knowledge of knowledge of stone tools** Students: – draw tools made with stones collected on Country – describe, compare and classify stone tools by key features (like shape and mass) and explain what makes them useful for crushing, grinding or cutting – compare, measure and order rocks suitable for grinding and crushing by mass – reflect on their classification of stone tools.	In Year 1, students: – compare directly and indirectly – order objects and events using attributes of length, mass, capacity and duration – communicate reasoning (AC9M1M01). In Year 2, students measure and compare objects based on length, capacity and mass using uniform informal units and smaller units for accuracy when needed (AC9M2M01).
Matt Burns (Quandamooka Traditional Custodian from North Stradbroke Island) shares his knowledge of stone tools describing the ways rocks were shaped into sharp edges as cutting tools.	**Share Indigenous Knowledge of stone tools used for cutting** Students: – draw the methods used to shape rocks into sharp edges – observe and compare rocks shaped into cutting tools – describe the edge angles of stone axe heads and other stone tools used to cut – order stone tools according to the edge angle – reflect on their order of stone tools and give reasons.	In Year 3, students identify angles as measures of turn and compare angles with right angles in everyday situations (AC9M3M05). In Year 4, students estimate and compare angles using angle names including acute, obtuse, straight angle, reflex and revolution, and recognise their relationship to a right angle (AC9M4M04).
Matt Burns (Quandamooka Traditional Custodian from North Stradbroke Island) shares his knowledge of stone tools and their use in grinding seeds. He also shares knowledge of the need for trading to get grinding rocks not commonly found on Quandamooka country.	**Share Indigenous Knowledge of stone tools used for grinding** Students: – draw the different stones Matt showed for grinding seeds – experiment with grinding seed using a grinding stone and flat rock or with a coffee grinder or mortar and pestle – use formal units to measure seed mass then compare to the mass of the ground flour and describe how long the process took – describe the quantity of seed needed to grind flour for different recipes of traditional foods – reflect on the process and describe what they found out in terms of mass and duration.	In Year 4, students interpret unmarked and partial units when measuring and comparing attributes of length, mass, capacity, duration and temperature, using scaled and digital instruments and appropriate units (AC9M4M01).

Indigenous Knowledges	Connecting Indigenous Knowledges and Mathematics	Connections to the Australian Curriculum
Bart Pigram (Yawuru man from Broome) shares his knowledge of using stone tools to remove oysters from their rocky surrounds. Bart demonstrates the angle required to remove the oyster from the rock.	**Share Indigenous Knowledge of stone tools** Students: – draw the tools and process shown by Bart to remove oysters from a rock – investigate striking objects at different angles – estimate then measure the angle – use angle names and relate angles to more than, less than or equal to 90° – record and show their investigations – reflect on the use of angles in traditional stone tools	In Year 5, students estimate, construct and measure angles in degrees, using appropriate tools (including a protractor) and relate these measures to angle names (AC9M5M04).
Jason Smith (Palawa man from Lutruwita) shares his knowledge of the natural resources on Palawa Country, such as rocks and stones used as tools for crushing, grinding and cutting. Jason describes grinding stones used to crush ochre into a powder. Ochre is in traditional body painting for ceremonial purposes. A wide range of colours are possible.	**Share Indigenous Knowledge of stone tools used for grinding and crushing** Students investigate ratio through creating a colour pallet based on a combination of 2-colour acrylic paints (commonly used in school art rooms) expressed as a ratio. An example is creating orange. Students could find the combination that provides the darkest orange. Students: – mix 3 parts red to 7 parts yellow (3:7) or 1 part red to 5 parts yellow (1:4) – communicate their ideas – share their colour pallets with the ratios shown – reflect on the process and comment on how ratio can be used make different tints of colour. – explain how they made the net.	In Year 7, students use mathematical modelling to: – solve practical problems involving ratios – formulate problems – interpret and communicate solutions, justifying choices made about the representation (AC9M7M06) In Year 8, students use mathematical modelling to: – solve practical problems (including financial) involving ratios and rates – formulate problems – interpret and communicate solutions, reviewing the appropriateness of the model. (AC9M8M07)

Fibre

Fibre includes knowledges on how native plants and grasses were used in the manufacture of string, rope, weaving dilly bags, baskets, and mats, traditional dress, fishing line, fishing nets. Different fibres were also used to make traditional dress, used for body decoration, bark canoes and building housing.

Design, technology and engineering

- The types of plants and grasses used for string and rope making
- The types of plants used for weaving, including lomandra, pandanus
- The types of plants and grasses used for making fish nets and fishing line for different size and mass of catch
- The types of plants used for making dilly bags
- Basket and mat weaving
- The types of bark used for making bark canoes
- The types of bark used in making housing or gunyas.

Body decoration

- Traditional dress and body ornaments (trochus and maireener shell threading for necklaces and other body decoration)
- Emu feathers were commonly used for decoration and traditional dress
- Body painting
- Beeswax, gum and sap used in body decoration

Indigenous Knowledges	Connecting Indigenous Knowledges and Mathematics	Connections to the Australian Curriculum
Matt Burns (Quandamooka Traditional Custodian from North Stradbroke Island) shares his knowledge of making rope and string. He shares methods to create thicker, stronger rope using the outside bark of the cotton tree. The inside bark that is softer makes thinner, finer string. Matt shares the uses of string for making spears, axes and jewellery. He describes how beeswax can waterproof the ropes and string to make them stronger.	**Share Indigenous Knowledge of ropes and string** Students: – draw the types of fibres showing differences like thickness and texture – use ropes and string to make direct or indirect comparisons and order them based on a certain feature – explain how the string and rope can be used.	In Foundation year, students: – identify and compare features of objects and events, including length, capacity, mass and duration – use direct comparisons and explain reasoning (AC9MFM01). In Year 1, students: – compare directly wand indirectly – order objects and events using features of length, mass, capacity and duration, and explain reasoning – this could include investigating where First Nations people estimate, compare and communicate measurements (AC9M1M01).
Jason Smith (Palawa man from Lutruwita) shares his knowledge of using bark, grasses and cork reeds for making canoes. He mentions that cork reeds help canoes to float. Jason shares his knowledge of using stone tools to cut and take bark from the tree in longer lengths. He shares the way the different layers of bark are used for different purposes. The inner bark can be used to make straps to tie items such as canoes. The next layer of bark can be made into string for basket weaving and rope that is thick and strong. Jason shares his knowledge of the importance of the natural resources including stringybark, grasses and cork reeds and the locations in making canoes for transport. He refers to Truganini, an Aboriginal woman, the daughter of Mangana, leader of a band of the south-east tribe of Tasmania. She used a bark canoe to travel and trade with other First Nation people.	**Share Indigenous Knowledge of canoe design and construction using fibres** Students draw designs of canoes. To do this they: – estimate the length of a canoe – draw the shape using chalk on a large flat area or model a canoe using cardboard or natural materials. Students reflect on their estimate and justify the process they used to come up with it.	In Year 3, students measure and compare objects using: – familiar metric units of length, mass and capacity – instruments with labelled markings (AC9M3M02).

Indigenous Knowledges	Connecting Indigenous Knowledges and Mathematics	Connections to the Australian Curriculum
Matt Burns (Quandamooka Traditional Custodian from North Stradbroke Island) shares his knowledge of collecting sap from Xanthorrhoea – the grass tree. He describes how the sap is heated and used as a glue. Matt uses a gluestick that holds the cooled sap and is a portable tool for fixing canoes and axes. Matt also describes how native beeswax is used as a resin and a type of glue and for waterproofing wooden tools.	**Share Indigenous Knowledge of using heat from fire to melt sap to make glue** Students: – draw a picture of the impact heat has on the ball of sap – use scaled instruments, such as a digital or standard thermometer, to measure the degrees (in Celsius) in different areas and of different objects – communicate their findings about temperature.	In Year 4, students interpret unmarked and partial units when measuring and comparing length, mass, capacity, duration and temperature, using scaled and digital instruments and appropriate units (AC9M4M01).
Matt Burns (Quandamooka Traditional Custodian from North Stradbroke Island) shares his knowledge of using ropes for nets to catch dugong and thinner string for nets to catch fish. Matt describes the size and shape of the nets that are design based on what animal they were trying to catch.	**Share Indigenous Knowledge of the design and construction of nets made from ropes and fibres** Students: – draw the shapes they see in the designs – draw a design of a fishing net fit for purpose and show how to calculate the area and perimeter of the net – reflect on the process and justify the shape and design of their net for the intended catch.	In Year 5, students solve practical problems involving the perimeter and area of regular and irregular shapes using metric units. This could include exploring the designs of traditional fishing nets, investigating the perimeter, area and purpose of the shapes within the designs (AC9M5M02).

Indigenous Knowledges	Connecting Indigenous Knowledges and Mathematics	Connections to the Australian Curriculum
Matt Burns (Quandamooka Traditional Custodian from North Stradbroke Island) shares his knowledge of using ropes and strings, explaining the different thicknesses and strengths. Jason Smith (Palawa man from Lutruwita) shares his knowledge of bark and the way the different layers of bark are used for different purposes. The inner bark can be used to make straps to tie items such as canoes. The next layer provides bark that can be made into string for basket weaving and rope that is thick and strong.	**Share Indigenous Knowledge of fibres** Students: – draw a diagram to show how to make string and ropes – design a fair test to collect data and compare how strong different fibres are based on the mass they will carry/hold – communicate their findings and suggest purposes for the fibres they tested – reflect on the process and justify the purposes for the different fibres.	In Year 7, students use mathematical modelling to: – solve practical problems involving ratios – formulate problems – interpret and communicate solutions – justify choices about the representation (AC9M7M06). In Year 8, students use mathematical modelling to: – solve practical problems involving ratios and rates, including financial ones – formulate problems – interpret and communicate solutions, reviewing the appropriateness of the model. This could include modelling ratio and applying it to make traditional string and ropes, including: – the ratio of length to the mass of a rope – the strength of the ply in proportion to a rope's pulling force – the proportion of fibre for the length of string required (AC9M8M07).
Matt Burns (Quandamooka Traditional Custodian from North Stradbroke Island) shares his knowledge of using ropes for nets to catch dugong and thinner string for nets to catch fish. Matt describes the size and shape of the nets that are design based on what animal they were trying to catch.	**Share Indigenous Knowledge of the design and construction of nets made from ropes and fibres** Students: – draw the shapes they see in the designs – draw a design of a fishing net fit for purpose and show how to calculate the area and perimeter of the net – reflect on the process and justify the shape and design of their net for the intended catch.	In Year 7, students: – recognise and use variables to represent everyday formulas algebraically – substitute values into formulas to determine an unknown. This could include using everyday formulas and applying them to Country/Place contexts, investigating the relationships between variables (AC9M7A01).

Indigenous Knowledges	Connecting Indigenous Knowledges and Mathematics	Connections to the Australian Curriculum
Jason Smith (Palawa man from Lutruwita) shares his knowledge of architecture and using bark from the stringybark trees for roofing. Jason explains how dogwood and teatree are bent into an arc frame providing a dome shape for building shelters. He describes the size and shape of the bark needed to build a large dome shelter. Jason shows how to remove long pieces of bark and talks about the health of the trees to ensure sustainable harvesting of bark.	**Share Indigenous Knowledge of traditional architecture** Students: – draw the shapes they see in the design of bark shelters – experiment and estimate the materials needed to make the frame and the structure's covering. Using the various nets, students could: – consider how and why changes in a shape or object's dimensions affect the perimeter, area, surface area, or volume, including proportional and non-proportional change – experiment to find the volumes and surface areas of composite solids by looking at the individual solids they are made from. Students: – recognise that the dome is half a sphere and make a connection with formula for volume and surface area of a sphere – justify how their formula is used to calculate volume and surface area.	In Year 9, students solve problems involving the volume and surface area of right prisms and cylinders using appropriate units. This could include looking at First Nations objects and technologies and: – analysing and connecting surface area and volume – exploring their relationship to their capacity (AC9M9M01). In Year 10, students solve problems involving the surface area and volume of composite objects using appropriate units (AC9M10M01).

Gathering food resources

This poster includes the types of tools, weapons and equipment used in gathering food resources. It covers all food sources including the collection of nuts and berries, meat and seafood and spans across water and land resources.

Tools

- Vessels for collection
- Digging sticks
- Harpoons and harpoon floats

Technology

- Fishing techniques, making fish and eel traps
- Making of killer boomerangs, spears, spear throwers
- Poisoning of water
- Sustainable harvesting of food resources

Sustainability

- Traditional lore and cultural protocols only taking what is needed, sustainability, totems
- Observation of seasonal indicators to ensure plentiful supply of food
- Tidal fish traps
- Methods of storing food
- Methods of preserving and storing fish for future use
- Knowledge of breeding pattern and growth for example the emu lays one egg every 3 days during November to March

Bush medicine

- Honey ants
- Native basil or native rosemary as mosquito repellent
- Emu and dugong oil
- Tea tree, eucalyptus, dugong and emu oil

Ceremony and Trade

- Eastern mullet run, bogon moth gatherings, bunya nut gatherings
- Sea turtles
- Cycad nuts, bunya nuts, walnuts, macadamia nuts, chestnuts, boab nuts
- Gathering of oysters
- Freshwater food like yabbies, mussels and crayfish
- Saltwater food like dugong, turtle and larger fish

Fish found in Australian waters being collected in a Coolamon.

Indigenous Knowledges	Connecting Indigenous Knowledges and Mathematics	Connections to the Australian Curriculum
Matt Burns (Quandamooka Traditional Custodian from North Stradbroke Island) shares his knowledge of bunya nuts as a food source. Bunya trees are ancient trees that have survived in Australia since the age of the dinosaurs. Bunya nuts are harvested each year between November and March with a larger crop every 3 years.	**Share Indigenous Knowledge of bunya nuts** Students: – use bunya nuts to count collections – present bunya nuts in different patterns – subitise or count collections – communicate their ideas. Students could mark the months when bunya nuts can be harvested.	In Foundation year, students partition and combine collections up to 10 using part-part-whole relationships and subitising to recognise and name the parts (AC9MFN04). In Year 1, students describe the duration and sequence of events using years, months, weeks, days and hours (AC9M1M03).
Matt Burns (Quandamooka Traditional Custodian from North Stradbroke Island) shares his knowledge of bunya nuts as a food source and for trade and barter. Jason Smith (Palawa man from Lutruwita) shares his knowledge of food such as mutton birds for trade and barter.	**Share Indigenous Knowledge about resources used for trading purposes where they are plentiful on different parts of Country** Students: – recognise trading of natural resources by First Nations people as a form of economy and an alternative to coins or money – role play trading natural resources.	In Year 3, students recognise the relationships between dollars and cents and represent money values in different ways (AC9M3M06).
Matt Burns (Quandamooka Traditional Custodian from North Stradbroke Island) shares his knowledge of bunya nuts as a food source. He describes travel between the island and the mainland to collect the bunya nuts.	**Share Indigenous Knowledge about bunya nuts and ways First Nation people travelled to source foods** Students: – locate the Bunya Mountains and Stradbroke Island (which Matt discussed) on a map – estimate and calculate the distance students would need to travel from school to the Bunya Mountains – investigate local cultural maps or other maps to estimate distances travelled – create a simple map using grid references or other ways to locate landmarks.	In Year 3, students: – interpret and re-create – in 2 dimensions – familiar environments, showing landmarks and objects relative to each other – explore land maps or cultural maps First Nations people would use to identify and find important landmarks such as waterholes (AC9M3SP02). In Year 4, students use grid references and directions to: – find and describe positions and pathways – make their own grid reference systems (AC9M4SP02).

Indigenous Knowledges	Connecting Indigenous Knowledges and Mathematics	Connections to the Australian Curriculum
Matt Burns (Quandamooka Traditional Custodian from North Stradbroke Island) shares his knowledge of boomerangs, including their design and use in hunting, fire making and weaponry. He shares measurements of duration of flight and distances when thrown.	**Share Indigenous Knowledge about boomerang design** Students: – draw different boomerangs showing the different angles, and estimate and compare to 90° – measure angles of boomerangs using protractors, for example, to find possible angle measurements of the interior angles if the boomerangs were to form a triangle Students can also: – conduct a fair test to throw balls of different types and compare distances thrown – communicate their findings and compare to distances boomerangs have been thrown.	In Year 5, students: – estimate, construct and measure angles in degrees, using appropriate tools (including a protractor) and relate these measures to angle names (AC9M5M04) – choose appropriate metric units when measuring the length, mass and capacity of objects and use smaller units or a combination of units to obtain a more accurate measure (AC9M5M01). In Year 7, students demonstrate that the interior angle sum of a triangle in the plane is 180° and apply this to determine the interior angle sum of other shapes and the size of unknown angles (AC9M7M05).
Matt Burns (Quandamooka Traditional Custodian from North Stradbroke Island) shares his knowledge of spears. He explains how a woomera, an extension of the arm, is used to deliver more power.	**Share Indigenous Knowledge about spear technology** Students: – draw their interpretation of angle of release and trajectory (pathway in flight) – use mathematical modelling to investigate the paths of projectiles. Students can also: – conduct a (safe) fair test using a broom stick – collect and interpret data and communicate their ideas – reflect on the process they used to investigate and report on the trajectory.	In Year 9, students use mathematical modelling to: – solve applied problems (including financial) involving change – formulate problems, choosing to use either linear or quadratic functions – interpret solutions in terms of the situation – evaluate the model and report methods and findings. This can include modelling practical concepts using simple quadratic functions, tables and graphs (hand drawn or using digital tools) and algebraically interpreting features of the graphs such as the turning point and intercepts, for example, paths of projectiles (AC9M9A05).

Fire

Fire starting

- How fire was traditionally made
- Resources required for making fire
- What to consider before starting fire, location, wind direction, wind speed

Purpose of fire

- Cooking, heating, signalling, torches,
- Uses for paperbark
- Polishing shells with ashes from fire
- Smoking ceremony for healing, bringing good spirits (Kerr, 2019)
- Manufacturing tools and weapons through the use of fire (Amery & Power, 2019)
- Fire as a tool of Indigenous ecological management
- Management of food resources
- Kangaroo fire drives

Fire intensity

- Land management, reproduction of vegetable food, forests, fruits and grass resources
- Caring for Country
- How certain plant species respond to fire
- Plant fire intensity tolerance
- Disruption of traditional fire regimes
- Cool fire ("means safety for animals, plants and people and for breathing smoke" (Kerr, 2019, p. 36) or low intensity, controlled fire.

One example of First Nations Peoples utilising mathematics within the natural environment is in the processes for building a fire. Once the fire is sparked, the process involves using small twigs, building to larger sticks, then to branches. This involves estimation of the correct size, and sequencing to build the fire up rather than put the fire out. In this example, mathematical concepts of size and sequence were used in daily practices.

Modern fire management practices are evident across Australia. One example of Indigenous Knowledges is the Fire and Weed Project being conducted by the Gangalidda and Garawa People with support from the Carpentaria Land Council Aboriginal Corporation (ACARA, 2019). This example sees the utilisation of mathematical practices in Measurement, Area, electronic mapping, financial literacy, monitoring and evaluation.

Knowledge of fire informed many processes including the connections provided through Poster 2 (Shells). To reiterate, the hot ashes from the fire were used in the cleaning and polishing process of trochus and maireener shells.

> ***"In my time, when we used to see our burning and other clans burning, we used to walk across their fires and see what would grow, what would come back. We would be doing monitoring and evaluation, the proper way, respecting everything. Country services people. What I mean by Country servicing people is, if people start walking through or managing country at the wrong time according to Balandar (European) calendar, that country can kill you"***
>
> **(Uncle Otto Campion, Bulmaniya, they call me, and I'm a Rembarrnga fella. Cited in Kerr, 2019, p. 39).**

Indigenous Knowledges	Connecting Indigenous Knowledges and Mathematics	Connections to the Australian Curriculum
Matt Burns (Quandamooka Traditional Custodian from North Stradbroke Island) shares his knowledge of traditional fire-starting methods. Matt uses the fire drill method, which uses a flat piece of wood as a base and a thin elongated stick as the 'drill stick'. He shows that by rubbing the drill stick between the palms of his hands, he creates friction between the stick and the base. This makes heat energy and ignites tinder material such as dry grass, or coconut fibre. The ignited material is then added to sticks and branches to make a fire.	**Share Indigenous Knowledge of creating fire using traditional methods of fire-starting** Students: – draw the order of events to start a fire – represent making a campfire using traditional fire-starting methods as a series of events – reflect on how well the sequence shows the fire-making process.	In Year 1, students describe the duration and sequence of events using years, months, weeks, days and hours (AC9M1M03). In Year 3, students recognise and use the relationship between formal units of time including days, hours, minutes and seconds, to estimate and compare the duration of events (AC9M3M03).
Jason Smith (Palawa man from Lutruwita) shares knowledge of gathering wood for fires for keeping warm and cooking.	**Share Indigenous Knowledge about the use of fire** Students: – draw the different types and sizes of wood to collect for a campfire – estimate the amount of firewood to cook a meal for 1, 2, 3 and 20 people, depending on the size of the gathering – justify their estimates.	In Year 5, students use strategies to estimate numerical solutions to problems (including financial) involving rational numbers and percentages. This could include estimation strategies to make decisions about traditional steam cooking in ground ovens, including: – catering for different numbers of people – resources needed for cooking (AC9M6N08).

Indigenous Knowledges	Connecting Indigenous Knowledges and Mathematics	Connections to the Australian Curriculum
Jason Smith (Palawa man from Lutruwita) shares his knowledge of fire and its use in land management practices on Palawa Country. He describes the approach of burning patches of land to form a mosaic pattern of areas. Jason shares his knowledge of firestick farming that is used to produce 'cool' fire. This is different to 'hot fire' from bushfires, which damages Country.	**Share Indigenous Knowledge about the use of fire in land management practices** Students: – draw ways to manage Country using fire and patterns of burning – create patterns to show areas of burning and non-burning – combine knowledge of the area of a rectangle and geometric patterns to map out a traditional approach to burning – use a number line to show daytime temperature in degrees Celsius – describe environmental factors such as wind and temperature that impact use of fire in land management – reflect on their plan and justify their approach.	In Year 6, students: – recognise and use combinations of transformations to make tessellations and other geometric patterns, using dynamic geometric software where appropriate (AC9M6SP03) – establish the formula for the area of a rectangle and use it to solve practical problems (AC9M6M02) – recognise situations (including financial) that use integers and locate and represent integers on a number line and as coordinates on the Cartesian plane (AC9M6N01).
Jason Smith (Palawa man from Lutruwita) shares his knowledge on health of Country. He describes how cultural burning encourages healthy regrowth of native grasses. Some of these are edible. Jason shares his knowledge of the poa grass (a low growing grass) and lomandra grass distribution. Firestick farming uses cool fire only on ground cover or low-lying debris. Cool fire does not travel up tree trunks to branches, which makes hotter fires by burning more fuel. This is the difference between cool burning as land management and bushfires which may burn out of control.	**Share Indigenous Knowledge about the use of fire in land management practices and the effects on regrowth of native grasses** Students: – draw the distribution of grasses of a small patch of land shown by Jason – use the drawing to describe the health of Country. Students also: – select an area of local land to study and measure the health of Country – in small groups, use a hula hoop or similar-sized object to randomly sample parts of the area – gather data and use mathematical modelling to show how to improve the health of Country – as a class, reflect on the different models shared by each group.	In Year 7, students use mathematical modelling to: – solve practical problems (including financial) involving rational numbers and percentages – formulate problems, choosing representations and efficient calculation strategies, using digital tools – interpret and communicate solutions in terms of the situation, justifying their choices (AC9M7N09). – In Year 8, compare variations in distributions and proportions from random samples of the same size from a population and recognise the effect of sample size on this variation (AC9M8ST03).

Indigenous Knowledges	Connecting Indigenous Knowledges and Mathematics	Connections to the Australian Curriculum
Jason Smith (Palawa man from Lutruwita) shares his knowledge of fire and its use in land management practices on Palawa Country. He describes burning patches of land to form a mosaic pattern of areas. He explains that this type of burning reduces fuel and encourages new growth to lure grazing animals for hunting. Jason describes impact on fire height and fire behaviour depending on slope height, fuel types and weather conditions. He explains cool fire and its importance to sustain and heal Country, and how they go out by themselves (self-extinguishing fires).	**Share Indigenous Knowledge about the use of fire in land management practices** Students: – list and draw the different factors that affect fire behaviour – use mathematical modelling to investigate the rate of fire spread under different weather conditions, fuel types and changes in landscape – communicate their findings – reflect on their modelling to explain the rate of fire spread.	In Year 8, students recognise and use rates to solve problems when comparing 2 related quantities of different units of measure. This could include investigating First Nations land management, such as: – the application of the rate of fire spread under different environmental conditions such as fuel types, wind speed, temperature and relative humidity – First Nations peoples' conservation of water by estimating rates of water evaporation based on surface area and climatic conditions (AC9M8M05). In Year 9, students use mathematical modelling to: – solve practical problems (including financial) involving direct proportion, rates, ratio and scale – formulate the problems and interpret solutions in terms of the situation – evaluate the model and report methods and findings. This can include exploring fire techniques in First Nations land management practices that use proportion relationships, including the rate of fire spread in different fuel types to wind speed, temperature and relative humidity (AC9M9M05).

Glossary

Anemometer	Measures wind speed. Most have four horizontal shafts arranged like the spokes of a wheel. The end of each shaft is cup shaped. The wind pushes the concave side of the cup more than the convex side, so the anemometer spins in the wind.
Bunya gathering	Held on 26 January each year on the mid-north coast of Queensland. An age-old tradition of many surrounding Nations of people coming together to celebrate the bunya harvest. Historically, it was a place of ceremony, celebration and trade.
Beaufort Scale	A naval officer in Britain's Royal Navy who correlated wave heights with wind speeds devised this scale in 1805. It has since been adapted for land use and is still used to report wind speeds in mountain weather forecasts.
Coolamon	A carrying vessel usually made by separating the outer bark from a white gum, mulga river red gum or bean wood tree. Used to carry babies, collecting food and for grinding seeds into flour for damper.
Dilly bag	A traditional Aboriginal bag, generally woven from vines or dried grasses. Worn around the neck to hold food like berries, meat and fish for transportation purposes. Sometimes has feather or animal fur inside the bag to stop food from falling through holes in the weave.
Emu in the sky	The black parts of the Milky Way. Represents stories of astronomy and seasonal knowledge.
Linnaean classification system	Western cultural worldview of naming, classifying and grouping. Similar to how the Australian Curriculum: Mathematics is grouped into Number and Algebra, Measurement and Geometry, and Statistics and Probability.
Maireener shell	A small spiral-shaped shell commonly known as the rainbow kelp shell collected in shallow seaweed beds. Continues to be used in threaded shell necklaces.
Mullet run	Signals time for good fishing. Sea mullet fish migrate to warmer waters around April each year up the eastern coast when cold temperatures in rivers and estuaries flush sea mullet out into the sea to spawn. Was a way for the La Perouse community to make money after colonisation while observing cultural practices. Also happened on Stradbroke Island for some families.
Scarred tree	A tree that shows the hollowed-out oval shape where a stone tool has been used to remove its bark for a canoe, shield or coolamon.
Shell midden	A pile or mound of clam, oyster, pippy, cockle or mussel shells where the meat was eaten and the shell discarded. Evidence of a large group of people feasting together.
Songlines	Oral maps of the landscape built into memory to aid in navigation (Norris, 2016) or well-travelled cultural tracks (Arrow, 2016).
Third Cultural Space	Where Indigenous and western knowledges meet and complement one another. See Third Cultural Space Guide for further information.
Trochus shell	A conical-shaped sea snail shell traditionally used in necklace threading and body decoration particularly in Tasmania.