# A guide for curriculum development First Nations Australians' Science

December 2024

Ah Chee, J., Bennett, R., Cirkony, C., Coutts, K., Fairbrother, L., Gunning, T., Raven, T., Sambono, J., Singh, L-J., Uink, B., Ziebell, A. Edited by Dr Kaye Price

### **Title Page**

Ah Chee, J., Bennett, R., Cirkony, C., Coutts, K., Fairbrother, L., Gunning, T., Raven, T., Sambono, J., Singh, L-J., Uink, B., Ziebell, A. (2024) A guide for curriculum development – First Nations Australians' Science. Australian Council of Deans of Science grant project. Published by Deakin University.



Editor: Dr Kaye Price Copy editor: Donna Menzies Graphic design: Komal Sutaria, Lea Piskiewicz



Lardil man, Tommy Wilson, the Wellesley Islands Ranger Coordinator, measures the width of a turtle track to determine the species of turtle that created it. Image captured by J. Sambono on Mornington Island, Gununa. Permission for publication granted by T. Wilson 2024

# Copyright

This work is licensed under a Creative Commons Attribution-NonCommercial-NoDerivatives (CC-BY-NC-ND 4.0) with the exclusion of any third-party material as indicated. This license enables re-users to copy and distribute the material in any medium or format in unadapted form only, for non-commercial purposes only, and only so long as attribution is given to the creator.

If you remix, transform or build upon the material, you may not redistribute the modified material. We have all relevant permission to publish this work.

© The research team 2024 (The research team includes Jordan Ah Chee, Rebecca Bennett, Connie Cirkony, Karla Coutts, Laura Fairbrother, Tiffany Gunning, Tui Raven, Joe Sambono, L-J Singh, Bep Unik and Angela Ziebell). Intellectual Property deliverables are owned by the research team. However, there are also specific rights attached to Joe Sambono's Intellectual Property rights, as mentioned in the guide.



Attribution – NonCommercial-NoDerivatives 4.0 International CC-BY-NC-ND 4.0

ISBN: 978-0-7300-0196-6

# **Approach and Recognition**

### Statement about our work process

This guide was developed through a collaborative co-design process between both First Nations and non-First Nations academics. Drawing on the seminal work of Professor Joe Sambono, it represents our collective understandings at the time of publication, informed by ongoing dialogue and the continuous development of our perspectives.

We acknowledge the limitation that this guide is not fully comprehensive; however, it serves as a valuable resource to support the incorporation of First Nations Australian content during the development of science curricula. It is intended to assist those responsible for advancing this important work in tertiary education.

### **Acknowledgements**

Thank you to our First Nations Advisory Group: Prof Christopher Lawrence, Gerald Turpin, Heidi Mippy, Dr Katrina Wruck, Renee Cawthorne, and Dr Tracy Woodroffe. Thank you to our editor Dr Kaye Price. Thank you to our visual designers Komal Sutaria and Lea Piskiewicz and copy writer Donna Menzies.

NAME ASMES OF ACHORA SMALCIN COUNTRY AUSTRALIA LOCALITY COOPERS CK. PEOPLE SOURCE RELITMEN COLL. South Australian Museum A 2185	Alkaline ash of <u>Acacia salicina</u> This ash was mixed with prepared pituri Locality: Cooper Creek, S.A.	A2184
1 Electronic Contraction	South Australian Museum A 2184	Price

First Nations Australians have long used Pituri leaf as a medicine to relieve pain and improve stamina. Pituri ash is often combined with *Acacia salicina* ash to increase the pH of the mixture which enhances the release and absorption of the active alkaloids, amplifying the medicines effects. Image captured by J. Sambono, courtesy of South Australia Museum

# **Table of Contents**

Title Page
Copyright
Approach and Recognition4
Table of Contents
Acknowledgment
Vision Statement
Purpose
Scope
Principles
For us, about us, with us
Critical reflection is an important process for the iteration of ideas
Educators should respond to continuous improvement and adaptation
The intersection of Eurocentric science and First Nations science as common ground 15
Teaching versus showcasing First Nations Australians' sciences
The use of cultural contexts to drive the teaching and learning of science
Goals
Background
Definitions
Indigenous Cultural and Intellectual Property (ICIP)
Curriculum Development
The Educator's journey
Framework for educators
A. Including First Nations Australians' cultures and histories appropriately
B. Curriculum development support
Case studies including First Nations cultures and histories in science
curriculum
Case Studies
Resources
References

5

# **Table of Contents**

Appendix A
About the Authors
Appendix B
What does ICIP mean for educators?   72
The First Nations Australian science continuum75
Appendix C
Appendix D
Using the IKAT to support how to evaluate resources
Example Framework template
Appendix E
Framework template

## Acknowledgment

We acknowledge the Traditional Custodians of the lands on which we work and learn around Australia. We pay our respects to the unique cultural heritage and diversity of Aboriginal and Torres Strait Islander Peoples, and continuing connection to Country and Place. We also acknowledge and respect Elders – past, present, and emerging. We acknowledge the kinship and deep connections that First Nations Peoples have to people and places.

In developing this framework for teaching First Nations science in Australia, we take a moment to reflect on the millennia of First Nations scientific knowledge. These practices demonstrate a deep understanding of natural systems, environmental stewardship and the intricate relationships between humans and the world around us. We value all these knowledge systems in the curriculum so that we can show just how critical they are to inform the science behind sustainability. We have worked to create a teaching and learning environment that foregrounds First Nations voices and deepens our appreciation of the continuing contributions of First Nations science to contemporary knowledge.



Full moon over Mithaka Country. Image captured by J. Sambono

### **Vision Statement**

### Science in higher education: First Nations Australians towards recognition, engagement, and participation.

Our vision is to create a transformative guide that supports the inclusion of First Nations Australians' cultures and histories into the science curriculum at the tertiary level. This initiative is designed to assist educators and highlights three key calls to action:

- Attract more First Nations learners by allowing them to see themselves and cultural backgrounds as recognised and respected.
- Ensure all learners are aware of First Nations Australians' cultures, histories, rights, the impacts of colonialism, and contributions to science.

• Produce a pipeline of more cross-culturally capable scientists for the 21<sup>st</sup> century.

We envision a guide that supports the inclusion of First Nations Australians' cultures and histories in science curricula by showcasing relevant knowledge, rather than teaching culture. This fundamental positioning ensures educators remain in a position that respects cultural ownership and authority. It is important to be mindful that the teaching of culture is only performed by the respective First Nations Australian Community.

The role of educators is to spotlight or illuminate relevant scientific contexts for all learners. This guide is based on the principle that all science is human science, and First Nations Australians' contexts can be used to enhance the teaching and learning of tertiary science concepts and skills.

The Framework that underpins this guide informs educators on what they can include in their teaching and learning while showing respect for First Nations Australians. This Framework will also be particularly useful for scientist's who are keen to learn how to respectfully collaborate with First Nations Communities. This Framework honours and emphasises Indigenous Cultural and Intellectual Property (ICIP) rights in these endeavours and acknowledges that colonial science has not always operated by these principles.

First Nations Australian educators are often tasked with the challenging

### **Vision Statement**

responsibility of navigating complex cultural and educational needs. With First Nations Australia being more culturally diverse than Europe, it is a common misconception to assume that any single First Nations Australian individual can authorise or have comprehensive knowledge of all aspects of this diversity. This misunderstanding places an unfair burden on First Nations Australian educators. Therefore, this guide and Framework is designed to be useful for both First Nations Australians and non-First Nations Australians.

The Framework will also clarify when educators may require permissions and a more integrated approach with Traditional Owners and knowledge holders. The Framework recognises the global benefits brought about by the production of new knowledge that arises when Eurocentric science respectfully collaborates with First Nations sciences.



Fire drills are constructed from hardwood and are spun rapidly on a piece of softwood. The resulting friction generates heat, causing the soft wood to ignite, which in turn can ignite dry grass or tinder placed on it. Image captured by J. Sambono

### Purpose

The purpose of the guide is to support those working in tertiary institutions throughout Australia to incorporate First Nations Australians' cultures and histories into the teaching and learning of science. In recognition of this important work, the Australian Council of Deans of Science (ACDS) has provided a grant to support the development of this guide.

The guide aims to highlight the importance of including First Nations Australians' content and contexts into university science curriculum, emphasising its contribution to science engagement, student learning, and the development of cross-cultural capability.

Non-First Nations educators have a responsibility to showcase First Nations sciences, as there are not enough First Nations educators to do so alone. The inclusion of these First Nations cultures and histories in curriculum is not a new agenda. First Nations people, such as Uncle Jack Patten, have been advocating for improved education outcomes since at least the 1930's (1).

This guide assists tertiary science educators to include First Nations cultures and histories in their science curriculum. This is critical to ensuring that the perspectives of First Nations Australians are elevated and included in the teaching and learning of tertiary science throughout Australia. The inclusion of such ensures that, at a minimum, universities are producing a pipeline of future scientists with fundamental awareness and respect for First Nations Australian science. This aligns with the National science research priorities (2).

#### The guide is intended to:

- Enhance and enrich the experiences of First Nations Australians in tertiary science education, encompassing both students and academics.
- Support university teaching staff to ensure undergraduates learn science that is inclusive of First Nations Australians' cultures and histories.
- Provide guidance to learning developers, curriculum designers, and academic staff on creating culturally appropriate content and how to effectively assess the appropriateness of learning materials and activities.
- Meet science threshold learning outcomes: understanding science (1.3) and personal and professional responsibility (5.2) (3).
- Foster cross-culturally capable staff and graduates.

### Purpose

- Develop staff and student cross-cultural scientific literacy toward creating 21<sup>st</sup> century scientists.
- Support universities to recognise and incorporate cross-cultural capability as a fundamental science inquiry skill of today.
- Be systems agnostic by working across diverse institutions.



Mosaic burning is a controlled fire management technique long used by First Nations Australians to promote biodiversity and reduce wildfire. Image captured by J. Sambono on Lardil Country

### Scope

#### In scope:

- Positionality, protocols, and colonial science impacts.
- Unpacking First Nations Australians' science.
- Guidance on what First Nations information to include and how to include that information.
- Resources related to the dot points above.

#### Out of scope: (minimal resources provided)

- Responsibilities of institutions.
- First Nations Community engagement models.
- Writing Intellectual Property agreements.



Middens are archaeological features consisting of domestic waste, such as shells, bones, and plant materials, accumulated overtime by First Nations Australians. Image captured by J. Sambono on Gangalidda Garawa Country



### For us, about us, with us

The driving principles of the Guide are to acknowledge and respect the diversity of First Nations Australians' cultures, traditions, and knowledge systems and recognise First Nations Australians' cultures and histories are valid and valuable alongside Eurocentric scientific knowledge.

### For us

Curricula that is more culturally engaging and relevant includes examples of historic and contemporary First Nations science successes and contributions. Such inclusions are important in helping "us" grow confidence and pride that leverages our funds of knowledge. First Nations Australian People feel mirrored in the curricula (4).

### About us

Important inclusions that showcase longstanding science capability amongst First Nations Australians that includes examples of First Nations botany, chemistry, ecology, physics, zoology, etc. This ensures all learners gain knowledge and awareness of First Nations cultures and histories as it relates to their science majors. This curriculum provides windows into First Nations cultures and histories for all students (4). This is "about us".

#### With us

Engaging with First Nations Australians' science is progressively contributing to the creation of new scientific knowledge and innovative products that deliver benefits for all. Academics can better prepare graduates with cross-cultural ethical and legal skills, and responsibilities that are needed in the 21<sup>st</sup> century. This highlights the importance of recognising and respecting the Traditional Owners of Country and Place and their role in supporting/authorising research. Scientists, regardless of their discipline, are either First Nations Australians or will interact with First Nations Australians, and therefore require an awareness of State/Federal regulations, policies and acts that apply to such interactions. These skills are essential when working "with us" and cultivate respectful and mutually beneficial cross-cultural science collaborations. Interpretation and perspective of 'For us, About us and With us', provided by Professor J. Sambono, 2024.

# Critical reflection is an important process for the iteration of ideas

Critical reflection involves understanding that the knowledge system you grew up with is not the only knowledge system that exists. It should be recognised that the education most tertiary educators received did not highlight First Nations sciences. This knowledge gap results in educators having to both improve their knowledge of the sciences while at times, also challenging assumptions and biases acquired from scientific training that generally failed to recognise and incorporate First Nations sciences. This is particularly relevant for First Nations educators who did not see their cultures and histories reflected in the curriculum or often being told they come from a non-science practicing culture. The Framework considers reflection as a tool to help us as educators understand our approach to science and our ways of practicing science.

# Educators should respond to continuous improvement and adaptation

This Framework encourages continuous improvement and adaptation of curriculum content based on understandings of our positionality, background and feedback. "Positionality is about our relationships between each other, the origins and formations of our ideas and knowledge, and the actions we credit to ourselves and others", for example, ideas formed through family identity (5). Educators should actively address the inclusion of First Nations cultures and histories, as outlined in university recommendations and performance targets, including the Australian Universities Accord (6) and the Universities Australia Indigenous Strategy (7).

# The intersection of Eurocentric science and First Nations science as common ground.

Though the term 'science' was coined relatively recently, the notion is that science "is taken to be as old as humanity itself" (8). First Nations Peoples have long established and maintained distinct, systematic and place-based knowledges, drawing on similar methods we still employ today, including classifying, inferring, questioning, observing, interpreting, predicting, monitoring, problem solving, and adapting (9)(10). These similarities point to an intersection of knowledges systems – an idea known as 'common ground', as illustrated in Figure 1.



Figure 1 Eurocentric scientific knowledge and First Nations sciences have common ground. (adapted from Stephens, 2003)

Figure 1 depicts the distinct aspects of two knowledge systems and highlights that they have areas of common ground. These include for example, a unified universe, empirical observation in natural settings, pattern recognition, verification through repetition, inference and prediction and properties of objects and materials (11).

Though the particulars of overlap may vary (see for example, Aikenhead & Mitchell, 2011 (12); Tsuji & Ho, 2002 (13), the point remains: "Focusing on the similarities between the two systems of knowledge rather than on their differences may be a more useful place to start when considering how best to introduce educational reform" (14). This Framework recognises the value of 'common ground' to connect ideas and processes common to both First Nations and Eurocentric scientific knowledges to explore and enrich tertiary curricula.

### **Teaching versus showcasing First Nations Australians' sciences**

The role of science educators is to showcase First Nations Australians' histories and cultures rather than teach culture. Teaching culture is the responsibility of the respective cultural group who owns the ICIP. Educators can showcase First Nations Australians' cultures and histories, much like a theatre spotlight operator. Science educators can refer to the Framework on page 26 (Figure 4) to determine when they can showcase First Nations Australians' science and when to collaborate with the respective Community. Showcasing First Nations Australians' science ensures that educators can respectfully reveal examples of First Nations Australians' cultures and histories that relate to their accredited curricula (15).

# The use of cultural contexts to drive the teaching and learning of science

This Framework encourages the use of cultural contexts to showcase First Nations Australians' cultures in the teaching and learning of scientific concepts. Culturally relevant tertiary science content is explored through the disciplinespecific concepts/phenomena that underpin them. This enables culturally specific inclusions of First Nations Australians ways of knowing, being, and doing without derailing the accredited curricula. This approach also ensures First Nations Australians are positioned as the authorities of their respective culture.

## Goals

### GOALS

#### **Cultural inclusivity**

Ensure that science curriculum reflects the diverse science achievements, contributions, ethical and regulatory considerations of First Nations Australians and Peoples of the world.

#### Authentic representation

Provide accurate and respectful representations of First Nations Australians' histories and cultures avoiding stereotypes or misappropriation.

#### Holistic understanding

Ensure all learners understand that the siloing of science discipline knowledge is a cultural tradition of Eurocentric scientific convention.

#### **Privileging voices**

Ensure curriculum is developed privileging First Nations Australians' voices and aspirations for inclusion in mainstream science curriculum.

#### **Critical thinking**

Increase academic critical thinking and reflection on Eurocentric science traditions and their historic/enduring exclusion of First Nations Australians being considered as scientists or capable of science. Consider its subsequent impacts upon inclusiveness, attraction, and the retention of First Nations Australian students in undergraduate science.

#### Empowerment

Empower First Nations Australian students and staff to see their cultural backgrounds as having long standing science traditions in their own right, valuable knowledge holders and contributors to contemporary scientific endeavours, fostering a sense of pride and belonging.

#### Obligations of a 21st century scientist

Contemporary scientists increasingly need to:

- Respectfully communicate, negotiate, and form agreements with respective First Nations Australians.
- Consider their legal and ethical obligations when engaging with First Nations Australians.
- Negotiate permissions to access lands.
- · Have awareness of regulatory frameworks and protocols such as heritage acts.
- Address ethical research challenges, including IP, as they relate to First Nations Australians and funding applications.

### Background

A movement towards the inclusion of First Nations cultures and histories, both internationally and nationally, has been gaining attention for some time. This guide is informed by global and national anti-racism (16) education priorities and First Nations Australian strategies. The inclusion of First Nations cultures and histories in the curriculum has been occurring for many years in health, education, and environmental science disciplines (17). However, the incorporation of First Nations Australians' cultures and histories into university science curricula has generally been slow. First Nations Australians' science has not been foregrounded in higher education science curricula as it has frequently been incorrectly viewed as unscientific (18). Including First Nations Australians in higher education science sparticipation and improve educational outcomes for First Nations Australian undergraduates, whilst concurrently ensuring all undergraduates gain a greater awareness of and respect for First Nations Australians' cultures and histories. Successful inclusion maintains curriculum alignment with the goals of universities and the peak bodies that govern them (15).

This guide aligns with the United Nations Declaration on the Rights of Indigenous Peoples (19), the UNESCO inclusive education priorities (20) and the UN Sustainable Development Goals (21). Australia is also a signatory to the World Intellectual Property Organisation (WIPO) Treaty on Intellectual Property, Genetic Resources and Associated Traditional Knowledge (22), which considers First Nations knowledge in the international patent system. This guide also aligns with the Universities Australia strategy by increasing the participation of First Nations Australian students in tertiary science, promoting non-First Nations engagement with First Nations Sciences, and improving the higher education environment for First Nations Peoples (23). Further, it aligns with the Australian Universities Accord by encouraging First Nations student participation in higher education and incorporating First Nations knowledge (6).

Many educators require guidance to effectively include First Nations Australians' materials and concepts into their science curricula. The Framework presented in this guide offers educators guidance for developing their curricula. It considers and addresses common fears such as offending or contravening cultural protocols and encourages all academics to expand their knowledge of First Nations Australians' cultures and histories.

#### Indigenous/Aboriginal and Torres Strait Islander/First Nations/First Peoples

In this guide, we use the terms Aboriginal and Torres Strait Islander and First Nations Australians and in doing so recognise that while people have personal preference, none of these terms are perfect and with the imperfection each carry nuanced residual forms of colonial power (24). However, the guide acknowledges and respects that others may choose different terminology, or may refer to themselves in relation to Nation, Country and/or Language.

This guide uses the term First Nations Australians to encompass the large array of different nations, each with their own culture, language, beliefs and practices. In the guide, the term Community refers to the First Nations Australian Peoples of their respective Country or Place. *Please refer to Resources – Respectful language, for additional information about Aboriginal and Torres Strait Islander respectful terminology.* 

### First Nations sciences/Indigenous sciences/Indigenous knowledges/traditional knowledge/traditional ecological knowledge/Indigenous cultures and histories

Globally, First Nations cultures and histories share commonalities across their diverse, holistic, and place-based knowledge systems - where there are no separate categories of knowledge, such as science and art (9). Tewa scholar, Gregory Cajete (25) explains, "there is no word in any traditional Native American language that can be translated to mean "science" (p75) as it is viewed in modern Western society. However, over recent decades terms such as "Indigenous science" have been used to describe what Cajete refers to as ' ... the collective inheritance of human experience with the natural world." (p81) (25).

Other terms include Indigenous knowledge (IK), Traditional knowledge (TK), Traditional ecological knowledge (TEK) and Indigenous knowledge systems (IKS). For this guide, we use the term First Nations sciences to acknowledge the many place-based knowledge systems that have been and continue to be practiced in the world. We use the term First Nations Australians' cultures and histories. We refer to histories as past, present, and future; and culture as the values, beliefs, technologies, and conventional actions of a Community (12).

Thus, First Nations scientific knowledges encompass a range of disciplines such as astronomy, botany, chemistry, ecology, geology, genetics, hydrology, medicine, meteorology, nutrition, physics, physiology, and zoology. They also encompass a range of technologies, for example the development of machines, specialised tools, weaponry, architecture, clothing, blankets, torches, nets, traps and domestic utensils (baskets, knives, chisels, sieves); as well as innovative physical and chemical processes including lithic heat treatment, detoxification, stone knapping, skin tanning, use of acids and alkalis, use of poisons, production of medicines, medicine delivery, cooking methods, production of pigments and dyes, production of adhesives, fire lighting methods and fibre, string and rope production. These cases provide examples of science-relevant cultures and histories of First Nations Australians (26).

### Western science/Western modern science/Contemporary science/ Eurocentric science

Previously known as natural philosophy or natural history, the term science was introduced in 19th century Europe as an academy-based discipline flowing from natural philosophy or natural history in 19th century Europe (8). While our current global scientific practice has been enriched by contributions from various diverse cultures (e.g., Africa, the Americas, China, India, the Middle East), these contributions have been modified to align with Western or Eurocentric worldviews. (8)(27). In other words, science has a distinct cultural perspective and as such, science has been described as: Modern science (25), Western science (11)(28)(29), Western modern science (30), Contemporary science (31) and Eurocentric science (32)(33). Post-colonial Australian sciences are taught through a Eurocentric lens.

For this guide, we use the term Eurocentric science to acknowledge the predominately European cultural influence on what is now considered a universal knowledge system.

### **Indigenous Cultural and Intellectual Property (ICIP)**

#### Rather than being a roadblock, understanding ICIP offers new possibilities to enrich the inclusion of First Nations cultures and histories in science curricula. It is often a pathway to opportunities.

Indigenous Cultural and Intellectual Property (ICIP) is a rights-based approach to respecting Indigenous knowledge systems. Terri Janke describes it as "based on the rights to self-determination, ICIP rights are Indigenous People's rights to their heritage and culture" (34). Terms like traditional knowledge and traditional cultural expression are often used to describe aspects of ICIP. Indigenous knowledge systems and associated rights do not fit neatly into the standard Western definition of Intellectual Property rights, which are based on the individual or a corporate entity. A breakdown of the various components that should be considered for ICIP are shown in Figure 2.

ICIP is an emerging and important consideration for educators. It is essential that we understand our obligations to uphold ICIP rights within the educational context. Specifically, science educators must acknowledge all First Nations science knowledge and knowledge systems as ICIP.



Figure 2 ICIP breakdown © Terri Janke and Company 2003 (adaptation of Janke T,...permission granted)

ICIP includes both tangible cultural heritage such as objects, art, tools and documentation of First Nations Peoples' heritage, and ancestral remains, as well as intangible cultural heritage including language, songs, symbols, and traditional ecological knowledge. Understanding ICIP rights will assist in understanding how to respectfully and appropriately use First Nations cultures and histories in science curricula.

The United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP) (19) comprising 45 Articles, affirms the commitment of the UN and its signatories, including Australia, to protect the rights of Indigenous Peoples worldwide. Article 31 reaffirms 'Indigenous Peoples have the right to maintain, control, protect and develop their cultural heritage, traditional knowledge and traditional cultural expressions'. Australia is also a signatory to the WIPO Treaty on Intellectual Property, Genetic Resources and Associated Traditional Knowledge (22), which considers traditional knowledge in the international patent system. See WIPO in the resource list to find out more about the treaty objectives. *Please refer to Appendix B: What does ICIP mean for educators, for additional information.* 



Ochre is a natural clay earth pigment containing iron oxide, ranging in color from yellow and orange to red and brown. Image captured by J. Sambono on Quandamooka Country

The following two sections provide support for curriculum development:

- · The educator's journey to aid in understanding positionality.
- The Framework for educators to support the appropriate inclusion of First Nations Australians' cultures and histories in curriculum.

### The Educator's journey

The educator's journey to include First Nations Australians' cultures and histories in curriculum begins with understanding our positionality, understanding ICIP, building our cross-cultural intelligence, and honing our curriculum development knowledge and teaching skills. *See Resources for prompts to consider your positionality*. Incorporating First Nations traditional knowledges in university science curriculum is an ongoing process. Educators should continually consider their position with a commitment to respectfully incorporating First Nations Australians' knowledges in their curriculum in a cross-culturally intelligent and discipline focused way. Positionality is interconnected with identity. *Please refer to Resources – Positionality prompts, for additional information*. Figure 3 represents the educator's journey as it interacts with the institution.



Figure 3 The educator's journey adapted from image by Helen Rysavy

Eurocentric science has long been critiqued for its positionality as an arbiter of truth and its exclusion or debasement of First Nations peoples' intellectual validity. Many outdated scientific ideologies brought forward through Eurocentric science continue to reverberate in First Nations Australian Communities and the wider public. The legacy continues to generate mistrust and scepticism on all sides. Australian science educators having a fundamental understanding of both Eurocentric science and First Nations Australians' sciences can empower science educators to break down barriers and improve cross-cultural engagement in contemporary science.

Therefore, when including First Nations Australians' cultures and histories in science curriculum, it is important to continue thinking about our positionality and to learn more about First Nations ways of knowing, being, and doing. For many, the educator's journey is a continuum. *Please refer to Appendix C: The continuum, for additional information.* The educator's learning journey should always begin by reflecting and revisiting our positionality throughout the process of including First Nations perspectives.



First Nations Australians have long used grinding stones to crush and grind seeds into paste or flour. Image captured by J. Sambono

### **Framework for educators**

Including First Nations Australians' cultures and histories in science curriculum requires a thoughtful and respectful approach that prioritises First Nations Australians' inclusiveness across three dimensions:

- Ensuring First Nations Australians can see themselves in science curriculum.
- Exposing all learners to First Nations Australians' cultures and histories relevant to science disciplines.

• Providing opportunities for all learners to develop cross-cultural capability required of 21<sup>st</sup> century scientists.

It is essential for science educators to understand that their role is not to teach First Nations Australians' culture but to showcase aspects of First Nations Australians' long standing scientific successes, contributions and considerations, ensuring alignment with accredited curriculum. *Please refer to Principles* – *Teaching vs Showcasing First Nations Australians' science, for additional information.* Of equal importance is the avoidance of unauthorised use of culture in curriculum. A general rule is to avoid investigation of closed ceremonies, and secret and sacred information, such as rites of passage (men's and women's business). *Please refer below to Section A. Including First Nations Australians' cultures and histories and appropriately - 2 First Nations Australians'* cultures and *histories secret/sacred considerations, for additional information.* 

This Framework assists educators in appropriately including First Nations Australians' cultures and histories both with and without Community partnerships. Educators must seek out credible sources of First Nations knowledge, ensuring accuracy, authenticity, and appropriateness in the usage. A critical analysis of the First Nations knowledges that the educator plans to showcase should be considered. The Indigenous Knowledges Attribution Toolkit (IKAT) (35) contained in *Indigenous Referencing Guidance for Indigenous Knowledges*, provides guidance on how to cite and reference First Nations authorship and First Nations knowledges. *Please refer to Appendix B: What does ICIP mean for educators?, for additional information on ICIP attribution and refer to Appendix D: Using the IKAT to support how to evaluate resources, for worked examples of using the IKAT*.

Figure 4 illustrates the concept of teaching versus showcasing curriculum, highlighting when curriculum can be developed independently and when it must be developed in collaboration with Community.

#### Curriculum development that can be undertaken independently

• Identify *(through desktop research)* culturally appropriate context for inclusion in the curriculum.

• Ensure critical analysis of sources and include First Nations knowledge attribution.

• Showcasing non-secret/sacred known facts (freely available information e.g.: published works) about First Nations Australians' science.

#### Curriculum development that MUST be undertaken with Community

• Deep knowledge (ICIP) owned by respective First Nations Peoples, used in teaching and learning by using specific science.

• Seek Community support through building reciprocal relationships with respective First Nations Australians' Community.

#### **First Nations world science context**

#### Australian context

**Regional context** 

Local/Specific context

Specific Peoples ICIP

Investigate the cultural science practice

Collaboratively align cultural science with discipline concepts

Using cultural science ICIP for teaching and learning

Figure 4 Supporting the inclusion of a First Nations Australians' cultural science context. Model derived from original by Sambono, J. 2021.(12) This model is Joe Sambono's intellectual property.

The Framework illustrated in Figure 4 exemplifies the depth to which an educator may go when incorporating a First Nations Australians' science context. It is generic in nature to demonstrate to educators how they can incorporate cultural science content into their curriculum. The goal is to showcase First Nations Australians' scientific knowledge and achievements, that align with Eurocentric tertiary scientific concepts studied – the common ground (Figure 1).

The Framework illustrates that a cultural context can be independently and appropriately introduced into teaching and learning at a broad factual level. Addressing ICIP will be determined by the depth to which you plan to incorporate the cultural science context. This is also known as respecting free, prior and informed consent, or the right of First Nations Peoples to self-determination in the use of resources and knowledges (36).

The orange and blue triangular-like shapes in Figure 4 are positioned to remind academics that as they go deeper and beyond the local/specific context (point of the inverted top triangle), less detail can be shared without the support of the respective Community. Whereas, when Community support is granted, the opportunity expands, as represented by the widening of the bottom triangle.

The top triangle guides academics through the process of introducing a First Nations Australians' science topic in a relevant and authentic way. In many instances, this is best done during the introduction of a discipline concept. For example, when teaching introductory organic chemistry, the inclusion of a respective First Nations groups usage of organic chemistry can be introduced using an overview of how First Nations peoples around the world have long employed organic chemistry in everyday life. This logically flows to discussion around organic chemistry usage in Australian and local/specific contexts, including contemporary usage of chemistry by First Nations Australians' and their continuing contributions. Following the progression of the top triangle, supports academics in their challenge to integrate First Nations Australians' science logically and seamlessly into their respective discipline.

Although the Framework is top down (Top triangle – Bottom triangle) it has the flexibility, depending on the academics' circumstance, to start anywhere in the top triangle.

The bottom triangle alerts academics that cultural support and authorisation is required for any deep exploration beyond general facts in the public domain regarding a specific First Nations groups science knowledge. The bottom triangle also provides space wherever possible to privilege your local contexts where you are teaching and working. *For further explanation please refer to the case studies*.

### A. Including First Nations Australians' cultures and histories appropriately

# 1. Showcasing First Nations sciences versus the teaching of culture

When developing First Nations curriculum in science it is essential to understand the role of educators who are outside Community and non-authority in culture. The teaching of culture remains in the domain of the respective Communities. This distinction is crucial, as unauthorised teaching of culture is likely to be considered highly offensive by the respective Community. As previously mentioned in this guide, the broader First Nations Australian Community has long called for educators to include First Nations Australian aspects in the curriculum. However, these requests are grounded in the collective goal to ensure all Australians learn fundamental truths and facts about First Nations Australians.

This can best be achieved respectfully by educators putting a spotlight on First Nations Australians' cultures and histories relevant to the tertiary science curriculum. Done successfully, the educator illuminates for their learners' examples of long-standing scientific traditions, successes, contributions, and considerations. For example, a physics educator delivering a unit on forces can do this appropriately in their lecture materials through an engaging overview on how First Nations Australians' have long experimented with physics phenomena. They may showcase the ingenuity of First Nations Australians' usage of physics concepts and their application of levers in hunting technology.

An example of the same educator 'teaching culture' and not 'showcasing' culture

would occur if the physics educator without cultural permissions/authority set an assignment for their students to go and build a replica spear thrower of the Wik People and demonstrate their proficiency in its usage.

Many science educators report a fear of doing the wrong thing and causing offence. Further, science educators frequently cite a lack of knowledge of First Nations Australians' cultures and histories. A recurring call from educators has been the need for guidance and support in the doing of this important work. The above Framework has been developed and included here to expressly support and address such fears and concerns.

### 2. First Nations Australians' cultures and histories secret/ sacred considerations

Many educators may inadvertently find themselves exploring and misrepresenting inside knowledges/practices. Cultural contexts relating to ceremony or ceremonial practices are areas that require deep consideration and sensitivity. They often require cultural authorisation for their sharing and are usually best left to be explained by the respective cultural group they belong to. This does not necessarily require in-person support; in many cases it can occur through the use of multimedia or published works by the respective knowledge holders themselves. Doing so, ensures cultural integrity and reduces accidental misrepresentation. In this Framework this relates to the bottom triangle (Figure 4). When collaborating with respective knowledge holders, you are working in the bottom triangle of this Framework.

Some ceremonial practices and protocols, however, are appropriate and useful for all Australians to have an awareness of. Furthermore, some are underpinned by and relate to tertiary science concepts. For example, when teaching Mendelian genetics, educators can include culturally meaningful curriculum related to moiety and skin classification systems, by using examples that are available in the public domain. This ensures educators can create curriculum independently by working in the top triangle of the framework. When teaching inorganic chemistry, introducing the production of widow caps could be appropriate. Widow caps are used by many cultural groups in central Australia such as the

Arabana People. These specialised caps made of plaster and weighing up to 7-8 kilograms are worn by grieving widows. Their purpose is complex and falls within secret and sacred ceremonial practices. However, they are a public mourning item not dissimilar to a black veil. These widow caps can be used as a context to showcase the traditional use of calcination of gypsum to produce the plaster for the making of these important mourning caps. By focusing on the chemistry of the widow cap, rather than the underlying ceremonial practices, the educator can remain in the top triangle of the Framework.

Thus, the Framework supports educators to understand the boundaries related to sharing First Nations Australians' cultures and histories. That is, to remain in the top triangle educators must focus on the general scientific facts to create curriculum independently. To go deeper into culture and thus beyond the educator's authority, you need to collaborate with Community, and you will be working in the bottom triangle.

### 3. Consulting with First Nations Communities

When considering whether to consult with Community, the needs of Community must come first. The shape and design of the Framework were developed to graphically illustrate that the closer and more detailed the content relating to First Nations Australians' cultures and histories, the less educators should independently share. This is represented by the top triangle being inverted and its bottom point being smaller to illustrate this concept. Conversely, as seen in the bottom triangle of Figure 4, working with Community/Knowledge Holders opens up greater possibilities for your curriculum development. This is represented by the layers increase in size with greater cultural authority and involvement. When thinking about working with Community, keep in mind the following:

• Consider the level of complexity needed and where the work falls within the Framework illustrated in Figure 4. If your curriculum inclusions are in the top triangle, direct Community consultation is not required.

• Where available, seek support from your institutions First Nations leaders in the development of your curriculum materials, including cultural audits of your work.

• Check with Community if they have the capacity to be involved. See out-ofscope resources for guidance in working with Community.

 Be considerate of how much assistance Community can provide and be mindful of bombarding Community with requests. Be mindful that the First Nations person you are working with will not be able to speak for all First Nations People or be able to do all the work you are seeking. Due to colonialisation, some members of respective Communities may not have the cultural knowledge being sought, and this can be distressing for individuals of the Community.

 Understand that establishing relationships with Community can take time and must be reciprocal.

• Reciprocal, respectful relationships involve people seeing each other as equal and coming together with a mutual benefit between groups (37). For example, sharing information produced, providing each other with access to resources or payment for services.

• Respectful relationships mean different things to different cultures, however at a minimum it requires consent between all parties. It is essential to understand the Community you are working with.

 There is no specific way of working with all Communities – be who you are and know where you are. Each Community is unique therefore each engagement model is different.

• When working in the field, it is your legal responsibility to protect and not disturb cultural heritage. Refer to the legal requirements outlined in your state/territory heritage acts. *Please refer to Resources: Heritage acts, for additional information.* 

### **B. Curriculum development support**

# 1. Find First Nations Australians' culture and histories resources and sources of information:

The first stage in curriculum development is to become familiar with the First Nations Australians' cultures and histories that overlap with your topic area. There is no shortage of information. However, it is essential to critically analyse independently sourced information to determine their reliability and appropriateness.

Due to the outcomes of schooling, many science educators are unaware or have not been taught about the long-standing scientific successes and practices of First Nations Australians. For many, a primary challenge is recognising and investing in improving their knowledge of these practices. Science educators face an additional challenge due to the lack of bespoke disciplinary texts. For example, there is no First Nations Australians' chemistry textbook. Furthermore, the disruption and absence of these knowledges in many (but not all) First Nations Australian Communities today, can be traced to the impacts of colonisation. In recent years, both First Nations and non-First Nations scholars have successfully mined the colonial archives to uncover examples of sophisticated scientific practices that have long been conducted, but are little-known to many science educators. Much can be gleaned by science educators when exploring the broad variety of primary, secondary, and tertiary literature. Many documented examples of First Nations Australians' knowledges, technologies, and processes provide a rich source of contexts that are directly relevant to tertiary science concepts taught in Australian and international universities. How cultural contexts are embedded within teaching and learning materials can vary widely. Cultural contexts can be used in lecture material, incursions/excursions, hands on inquiries, through to assessment items.

Tertiary science educators who embark on this important work need to develop the ability to research and distil the science from a broad range of sources, ranging from personal communication with knowledge holders/Elders, material culture, through to early colonial journals. This requires the application of

fundamental culturally responsive practices that ensure all teaching and learning materials do not perpetuate offensive or deficit narratives. Many sources can be inappropriate as they may contravene cultural protocols and offend the people involved. GenAI can produce inaccuracies (i.e. hallucinations) and contravene cultural protocols. Sources of information should be selected with careful evaluation. It is essential that inappropriate cultural material is not used. Educators can develop their cultural capability skills in selecting and evaluating appropriate resources.

Using a critical framework, like the Indigenous Knowledges Attribution Toolkit Decision Tree (38) (Figure 5) can assist in ensuring you are selecting appropriate materials or are aware of the risks of particular sources. Consider the authorship, who contributed to the source, when the source was created, how it positions First Nations Australians, and if it could include cultural elements considered to be secret or sacred.



First Nations Australians have long used the mineral gypsum as a pigments and plaster for ceremonial purposes such as body painting and mourning caps and as an adhesive and binder for buildings, tools and weapons manufacture. Image captured by J. Sambono



Figure 5 Indigenous Archives Collective: Faulkhead ST, K; Sentance, N; Booker, L; & R Barrowcliffe,. Indigenous referencing guidance for Indigenous knowledges / CAVAL & the Indigenous Archives Collective. Indigenous Referencing Guidance for Indigenous Knowledges. Indigenous Archives Collective and the UTS Jumbunna Institute of Indigenous Education and Research.; 2023. CC BY-NC-SA 4.0

#### Source limitations and considerations

While it is important to find sources of information on First Nations Australians' cultures and histories, written records can be problematic and should be approached with caution. Written records can draw from non-First Nations interpretations of records and observations of First Nations Peoples' actions, comments, traditions and behaviours. These interpretations can privilege the Western paradigms of the authors and include inappropriate attitudes and language from the past. These written sources of information can lack the perspectives of the people they describe and may be based on outdated scientific concepts. As a result, this guide strongly advises educators to either self-audit their teaching and learning materials (using suggested tools) or, when available have them audited by First Nations Australian curriculum specialists. Throughout Australia, various tertiary institutions are establishing Communities of Practice to deliver this essential support.

### 2. Write an educational plan

- Identify the opportunities to align the curriculum with unit and course Learning Outcomes (LOs).
- Choose the unit topics that you wish to explore.
- Source information on related First Nations sciences from library resources or reliable online sources.
- Draft your LOs ensuring LOs are measurable by assessment.
- Draft your curriculum what do you want your students to know, understand or be able to do? Curriculum planning documents are available in Resources.
- Ensure curriculum is scaffolded across year levels.

• Ensure First Nations content is delivered as a meaningful part of the curriculum. To ensure that efforts are not tokenistic, avoid treating First Nations science as an afterthought, checkbox or using only brief mentions in the curriculum. *Please refer to Resources: Teaching and curriculum resources, for additional information.* 

• Ensure students develop cross-cultural skills relevant to their discipline, such as cultural awareness, effective communication, and collaboration across diverse cultural contexts. These 21<sup>st</sup> century skills are essential for scientists working in this globally interconnected environment. *Please refer below to Section B 3. 21<sup>st</sup> century cross-cultural science skill development, for additional information.* 

· Consult the Framework for the depth of engagement.
- Draft any plans for Community advice (if required).
- Draft your assessment plan. *Please refer below to Section 5. Aligning assessment, for more information.*
- · Consider the context of your university when developing your plans.

### 3. 21st century cross-cultural science skill development

In the 21<sup>st</sup> century, developing cross-cultural skills is essential for equipping individuals with the ability to understand, appreciate and effectively engage with diverse cultures. Teaching these skills to emerging scientists is crucial to help them navigate an increasingly globalised scientific community, address complex challenges, and ensure they are prepared for the workforce of the future.

One of the most significant drivers for contemporary scientists to develop crosscultural skills in Australia is the rapid shift in land tenure coupled with a shift toward First Nations Australians taking on roles as co-designers, collaborators, decision makers, and employers. Regardless of science discipline, scientists will need to engage with the respective First Nations Australians of the land on which their research is conducted on, about, or from where the subject matter is derived (39).

Scientists of today and tomorrow need to consider their legal and ethical obligations when engaging with First Nations Australian peoples' cultures and histories. Scientists must respectfully communicate and negotiate access to lands, use of ICIP, and establish agreements/partnerships/protocols with respective First Nations Australian agencies/corporations/groups/communities/ Elders/knowledge holders. New funding agreements increasingly require scientists to demonstrate how they will prioritise and address critical ethical research requirements. This approach enhances preparedness and ensures the effective application of contemporary research practices. Therefore, it is essential that these emerging professional requirements are integrated and modelled within undergraduate science programs.

#### **Curriculum development opportunities**

• Most Bachelor of Science programs have course learning outcomes that address fundamental social and ethical behaviour considerations; however,

these could easily be expanded upon to include the teaching and learning of 21<sup>st</sup> century cross-cultural science skills mentioned above. An example of using learning outcomes to fulfil these commitments is the recent reaccreditation of the Bachelor of Science course at Queensland University of Technology (QUT). It now includes course learning outcomes requiring students to value Indigenous perspectives and contributions and emphasises culturally appropriate ethical practice.

A good starting point is an investigation into the impacts of colonial science upon First Nations Australians. This is essential in understanding why some First Nations Australian individuals and communities may have a mistrust of science.
It is helpful to teach students about being in partnership with First Nations people. *Please refer to Resources: Cultural learning opportunities*.

### For fieldwork or projects on or about a respective Country:

• Ensure students learn about the Community, language, culture, and history of the respective Country.

• Ask students to investigate the relevant protocols and access conditions to the Community they are considering working with. *Please refer to Resources for Cultural protocols and Cultural learning opportunities*.

• Ask students to find and read the relevant heritage act and regulations for the area they will be working in.

#### Collaborating with First Nations Community on projects and fieldwork:

• Ensure opportunities to learn how to build positive reciprocol relationships are included in curriculum.

• Ask students to reflect on how they interact with others and to talk about how they will work in partnership with Community.

• Design projects that are collaborative, reciprocal, and work in the Common Ground between Eurocentric science and First Nations sciences.

• Be clear with students about the agreed working relationships with Community and the area of culture that will be part of the collaboration.

 Include in the assessment a requirement for students to report on the details of Country, the traditional owners, and the student's consideration of the Community and the heritage acts.

### Adhering to regulatory frameworks/law/agreements/declarations

Include in the curriculum opportunities to explicitly teach students about regulatory frameworks e.g.: World Intellectual Property Organisation (WIPO) (22), UN Declaration (19), issues around bio-piracy, Nagoya protocol and the convention on biological diversity (40), and heritage acts. *Please refer to Resources: Heritage acts, for information of heritage acts around Australia.* The UNDRIP declaration has many implications for 21<sup>st</sup> century scientists. For example, see Articles 1, 12, 18, 26 and 31, plus others (19).

### 4. Sustainable curriculum

• Creating content is an iterative process involving continuous piloting and revision.

• Be guided by the principle of taking risks and correcting errors when necessary. Use various tools and methods, such as reflection, peer and student feedback, and formal or informal learning, to assess cultural appropriateness. Make adjustments as needed to ensure the content aligns with cultural expectations.

• First Nations content should be dynamic and evolve over time. To create a sustainable curriculum, it should be revisited each year of the program to ensure it remains appropriate, culturally safe and up to date with cultural nuances and where appropriate revisit Community engagement.

#### What success looks like for your curriculum

• First Nations Australian sciences are meaningfully embedded throughout your curriculum.

- · If contexts are reused they should increase in complexity.
- Your curriculum development is undertaken according to the Framework in Figure 4.
- Science concepts are taught in a variety of ways including the use of the First Nations Australians' science contexts.

### What success looks like for graduates

- Improved First Nations engagement, retention and graduate numbers.
- Graduates who are knowledgeable about First Nations Australians' cultures and histories, particularly in the context of science and in particular disciplines.

• Graduates who are aware of relevant regulatory frameworks and protocols pertaining to First Nations Australians'.

• Graduates who recognise First Nations Australians' ways of knowing, being and doing, including awareness of intellectual achievements and contributions to science in the past, present, and in the future.

• Cross-culturally aware and capable graduates leading the way in forming successful research collaborations with respective First Nations Australian Communities.

• Engagement with First Nations Australians knowledge and practices is increasingly leading to the development of new scientific knowledge and associated products that benefit all.

• First Nations Australians are increasingly assuming roles as formal managers and co-managers of lands throughout Australia, facilitated by mechanisms such as land tenure shifts.

### 5. Aligning assessments

• It is essential that assessment tasks assess the scientific knowledge relevant to the respective culture and history or are a reflection on those cultures and histories, rather than personal value perceptions.

• If educators develop First Nations Australians' cultural knowledge in the curriculum in collaboration with Community, the assessment of these respective cultural elements can only be marked by the First Nations People from that Community.

• All assessments must map/align to specific course and unit learning outcomes and be used to measure the level of achievement of those outcomes, in accordance with TEQSA's Higher Education Standards Framework (41).

Consider your university context and approach when designing assessments.

• Establish clear expectations and a shared understanding of criteria with your marking team.

• When using reflection for assessment, only the quality of the reflection can be assessed. Ensure that the assessment rubric contains criteria for the learner to demonstrate culturally respectful language. *Please refer to Resources: Using reflection as assessment.* 

 Consider use of appropriate technical and respectful language to ensure students are learning to explain observations and other concepts in a professional and scientific manner.

 When content is not assessed, students may perceive it as less important. Therefore, incorporating assessment in First Nations science lessons and materials offers educators an opportunity to emphasise critical concepts. This approach also helps to correct any misconceptions that students may have developed.

• This guide may be part of a broader initiative by your university to embed First Nations Australians' knowledges into course curriculum. Therefore, there might be other graduate or course learning outcomes that may be assessed related to critical thinking, ethical reasoning or inter or cross-cultural reasoning.

# Case studies including First Nations cultures and histories in science curriculum

These case studies provide examples of how to incorporate First Nations Australians' cultures and histories into science curriculum using the Framework. They include exemplars and highlight areas for improvement. The case studies can guide thought processes in the application of the Framework across different disciplines and common issues that may arise.

When delivering curriculum, the educator's role is to challenge any racist stereotypes and to be mindful of their own 'hidden curriculum'. The hidden curriculum refers to the unofficial and often unintended inclusion of values, norms, perspectives and beliefs that are not documented or part of the official curriculum, but which students are nonetheless exposed to in the classroom (42).

Pedagogical advice is out-of-scope; however, the goal is to teach relational components of First Nations Australians' cultures and histories by modelling the concepts. That is, building trusted and respectful relationships with our students to create a safe learning environment. *Please refer to Resources: Relationality, for additional information.* Learning must be experiential and dialogic, encouraging students to engage by working through the process. If resources contain offensive or outdated content, that content should not be used directly as curriculum, however, the issues within the resource can be used as discussion points, with adequate framing around what is and isn't appropriate within the piece/resource.

### Case study exemplars

The following case studies exemplify culturally meaningful and inclusive contexts (For Us) and ensures all learners have an opportunity to learn about First Nations Australians' as relevant to the discipline studied (About Us). The final case study illustrates how a teaching academic may incorporate 21<sup>st</sup> century cross-cultural science skills, required when working with, and on, the lands of First Nations Australians (With Us). *Please refer to Principles: For Us, About Us and With Us, page 12 for additional information.* 

### Subject: Biology

### **Topic:**

**Biodiversity & Classification Systems** 

### **Tertiary Context:**



Evening sky over mosaic burning on Lardil Country. Image captured by J. Sambono

Second Year 'Ecology and Biodiversity' – 'Identify and describe the fundamental drivers of patterns in diversity' From: Monash University, BIO2011, accessed 2024. <u>https://handbook.monash.edu/2024/units/BIO2011?year=2024</u>

#### Aim:

To review the development and application of the Linnaean classification system and showcase examples of other classification systems that have been established prior to the 1700s.

### **Background Research:**

Aboriginal and Torres Strait Islander Peoples have long relied on observation to classify living things and to distinguish between living and non-living things. Living things may be classified by physical features, habitat, or purpose. Further classification may include characteristics such as life cycle stage, sex, age, condition, practice or function. Such classification systems are specific to a given local context and help distinct groups to have a shared understanding within that group.

From the Euroscience perspective, the Linnaean system of classification was developed in the 18<sup>th</sup> century and has been taken up globally. This system initially organised living things based on their structural similarities. The system now organises them by domain, kingdom, phylum, class, order, family, genus, and species. Digital technologies now enable scientists to determine the genetic relatedness (DNA) of organisms. The Linnaean system has a global context to enable people across the world to have a shared understanding.

Both types of systems share many similarities. Early versions of the Linnaean system identified two distinct kingdoms: plants and animals. Similarly, many First Nations Australians also recognise two distinctions: animal and vegetable. For example, the Barngarla Peoples in South Australia classify animals as *paru* 

and vegetables as *mai* (43). The Ngaanyatjarra Peoples of Western Australia classify animals as *kuka* and vegetables as *mirrka* (44). Many First Nations Australians' classification systems of edible plants and animals are hierarchical, with organisms grouped in levels, and each of the higher levels encompassing the levels below, sharing similar protocols as with Linnaean taxonomy.

#### **Resources:**

The Australian Curriculum, version 9.0 website <u>https://www.australiancurriculum.edu.au/media/5653/ccp-tbi-f-6-ver5-online.pdf</u> (p. 116-120)

### **Refer to the Framework:**

This example sits in the top triangle of the Framework by introducing the topic using the Australian context before narrowing down local/specific contexts. This approach enables a teaching academic to create this curriculum independent of Community.

#### **Student Learning Outcomes:**

By the end of this topic, students will be able to explain Eurocentric classification systems including the similarities with First Nations systems of classification and ordering. Students will be able to discuss the purpose of classification systems and how each generate particular insights about the natural world.

### Learning Activity:

Generate a worked example using the Linnaean system and one using a local First Nations example. Explain the logic behind each system as it applied to the worked example (e.g., purpose, application). Discuss how both systems might be applied to find unique insights and knowledges about biodiversity.

#### **Assessment:**

To explain how recognising different systems might bring about unique understandings of the natural world.

### Subject: Chemistry

### **Topic:**

### Protein/enzyme denaturation

### **Tertiary Context:**



Grind stone used for grinding nardoo. Image captured by J. Sambono on Mithaka Country

'Food Chemistry'. 'Examine the formation of chemical complexes under different conditions and apply to macro and micronutrients in foods.' From: Murdoch University, FSN601, accessed 2024. <u>https://handbook.murdoch.edu.au/units/03/</u> FSN601

### Aim:

To illustrate the process of protein denaturation and showcase examples of how First Nations Australians' apply these ideas for food preparation and nutrition requirements.

### **Background Research:**

First Nations Australians' have long used heat treatment of food plants to ensure they are safe to consume. Heat treatment denatures proteins including enzymes. An article in ABC science explored how the Traditional Custodians of Channel Country/Cooper Creek drainage basin, use heat to pretreat the food plant Nardoo to make it safe to consume. Nardoo contains the enzyme thiaminase, which if ingested, can denature thiamine (Vitamin B1) in the body, leading to thiamine deficiency. Vitamin B1 acts as a coenzyme in carbohydrate metabolism through the decarboxylation of alpha ketoacids.

Thus, applying a heat treatment to Nardoo prior to consumption, denatures the thiaminase enzyme, avoiding the breakdown of thiamine (Vitamin B1) in the body, so that the plant products can be safely eaten. The Nardoo is triturated to make flour and then treated with heat. Without the treatment, the use of Nardoo as a food causes Beri-Beri disease that can result in death. The ABC article listed a range of references that could be investigated. A short ABC video clip, narrated by First Nations presenter Clarence Slockee, a Cudgenburra/Bundjalung man, describes how the consumption of untreated Nardoo by the colonial explorers Burke and Wills resulted in their deaths due to Beri-Beri.

### **Resources:**

ABC website, ABC Science articles, Environment and Nature <u>https://www.abc.net.</u> au/science/articles/2007/03/08/2041341.htm

ABC website, ABC Gardening Australia, Stories https://www.abc.net.au/gardening/clarence-slockee/9430764

### **Refer to the Framework:**

This example sits in the top triangle of the Framework and showcases a local/ specific Australian context. This approach enables a teaching academic to create this curriculum independent of Community.

### **Student Learning Outcomes:**

By the end of this topic students will be able to explain that heat denatures protein structures, by disrupting non-covalent bonds. This results in the unfolding of the proteins structure. Student will be able to explain this process using the case study presented on Nardoo, and thus demonstrate their knowledge that First Nations Australians have long used denaturation to pre-treat Nardoo to make it safe to eat.

### Learning Activity:

The above-mentioned ABC video clip on Nardoo will be used as a hook to engage students in the topic. The ABC article will form the basis of a showcase on the application of heat denaturisation of food plants before exploring the underlying chemistry of non-covalent bonds. Or students in higher years could look at the complicated structures within assembled enzymes structures that can only be present due to a vast array of non-covalent bonds.

#### **Assessment:**

To explain the scientific concept of protein denaturation and how First Nations Australians' have long applied their empirical understanding of using heat to detoxify plant food products.

Alternatively higher year levels can be asked to further extend the concept of denaturation by explaining or exemplifying the importance of non-covalent bonds in an important enzyme, e.g. Thiaminase.

### Subject: Environmental Science

### **Topic:**

Seasons

### **Tertiary Context:**

First year 'Earth, atmosphere and environment'. 'Synthesise and explain how the fundamental physical, chemical, and biological processes change the earth's surface over time, including how they affect and shape landforms, ecosystems, weather and climate.' From: Monash University, EAWE1022, accessed 2024. <u>https://handbook.monash.edu/2024/units/EAE1022?year=2024</u>

### Aim:

To explain the Eurocentric concept of seasons and showcase examples of First Nations seasonal calendars, highlighting their geographical diversity and differences to traditional European concept of four seasons.

### **Background Research:**

Across the globe, First Nations Peoples have tracked daily and seasonal changes by observing the movement of celestial bodies, weather patterns, and the life cycles of plants and animals (44). Further, First Nations Peoples have identified specific signs of seasonal change to inform the timing of events, such as the availability and harvesting of resources, along with the timing of gatherings, movement, and land management practices (44).

Across Australia, First Nations Peoples' have created their own seasonal calendars to reflect their local environments and climatic conditions. For example, the Miriwoong Peoples whose traditional lands occupy parts of Western Australia and Northern Territory, have a three-seasons calendar, whereas the D'harawal Peoples of the region north of Sydney have a six-seasons calendar (44).

Following a Eurocentric science perspective, early calendars – the Julian and Gregorian calendars were based on the solar year, with most of the world currently using the latter, often besides a traditional calendar (e.g. the lunar calendar's use in much of Asia). Within the solar year, seasons were determined by tilt of the Earth's axis, resulting in differences in the sunlight intensity as the Earth orbits around the



Shoreline demonstrating tidal fish traps on Lardil Country. Image captured by J. Sambono

Sun (44). Specifically, the four seasons are described as solstices (summer, winter) or equinoxes (vernal, autumnal).

#### **Resources:**

Bureau of Meteorology, Australia http://www.bom.gov.au/climate/about/

Australian Curriculum, version 9.0 website, Aboriginal and Torres Strait Islander Histories and Cultures.

<u>https://www.australiancurriculum.edu.au/f-10-curriculum/cross-curriculum-</u> priorities/aboriginal-and-torres-strait-islander-histories-and-cultures/

#### **CSIRO** Australia

https://www.csiro.au/en/research/indigenous-science/indigenous-knowledge/ calendars

### **Refer to the Framework:**

The example introduces the topic starting with the world context before narrowing down to local/specific contexts. This approach enables a teaching academic to create this curriculum independently.

### **Student Learning Outcomes:**

By the end of this topic, students will be able to explain the Eurocentric definitions and applications of seasons and recognise regionally specific examples developed by First Nations Australians.

### Learning Activity:

Explain and represent the four seasons from a Eurocentric perspective. Select an example of a First Nations Australian calendar, identify the number of seasons, explain what factors determine the seasons, and identify relevant indicators for seasonal change. Compare one Eurocentric season with a similar one in the First Nations calendar and describe the insights each offer.

#### Assessment:

Compare and contrast one season from the Eurocentric calendar with one from a First Nations Australians' seasonal calendar.

### Subject: Food Science

**Topic:** 

Nutrition

### **Tertiary Context:**

The Kakadu plum is a fruit high in vitamin C that has long been used by First Nations Australians for its medicinal properties. Image captured by J. Sambono on Larrakia Country

'Food Society and the Environment'.

'This unit provides students with an understanding of the socio-cultural, historical, geographic, environmental, and political factors influencing contemporary food systems. A critical appreciation of the factors influencing food choice in different populations locally and globally with particular reference to First Nations' foodways will be developed. Issues of environmental sustainability and planetary health in food systems will be explored.' From: Charles Darwin University – NUT304, assessed 2024.

With special thanks to the authors, Judith Myers, Senior Lecturer, Nutrition and Dietetics, Charles Darwin University and Kelly Stephenson, First Nations Consultant Dietitian; Director Hunter Nutrition Specialists, Greater Newcastle area.

### Aim:

To explore environmental sustainability measures of various food systems and the implications for human and planetary health, by showcasing the role of Food Sovereignty principles within promotion of sustainable foodways of Australia's First Nations Communities.

### **Background Research:**

Food sovereignty asserts the rights of peoples to nourishing and culturally appropriate food produced and distributed in ecologically sound and ethical ways, and the right to collectively determine their own food and agriculture systems. First Nations Peoples have been long thought of and referred to as 'hunter gatherers', but, as First Nations groups have always known, use of the land and waterways for food and other resources involved complicated and well-developed practices to manage the land and provide abundant food throughout the seasons.

This deliberately erroneous colonial narrative fails to recognise the complexities

and intricacies of the food systems that were part of Aboriginal and Torres Strait Islander Peoples' lives for tens of thousands of years and reduces these complex engineered, intricate, nutritional and cultural food systems to a simplified nature grounded in a colonised discourse (45).

The current Australian Food system acknowledges approximately 6,400 Indigenous foods and ingredients, however currently less than less than 1% of profits from traditional foods are returned to local owners (46). The author, John Newton writes: 'We celebrate cultural and culinary diversity, yet shun foods that grew here before white settlers arrived. We love 'superfoods' from exotic locations yet reject those that grow here. We say we revere sustainable local produce yet ignore Australian native plants and animals that are better for the land than those European ones' (47).

In the Northern Territory, the Kakadu Plum is a well-known traditional fruit associated with the northern regions of Australia. Known for high concentrations of Vitamin C, and association with traditional practices for thousands of years. Unfortunately, it has also been associated with legal action, patents, and misrepresentation. The following article and web pages highlight some of the history associated with the Kakadu Plum in Australia including erroneous misrepresentations and erosion of food sovereignty principles, contributing to the undermining of health and nutrition of First Nations' communities.

#### **Resources:**

Australian Government. State of the Environment 2021. <u>https://soe.dcceew.gov.</u> <u>au/indigenous/management/caring-country</u>

Newton JS. The oldest foods on earth: a history of Australian native foods with recipes: New South Publishing; 2016.

Wilson A, Wilson R, Delbridge R, Tonkin E, Palermo C, Coveney J, et al. Resetting the Narrative in Australian Aboriginal and Torres Strait Islander Nutrition Research. Current developments in nutrition. 2020;4 (5).

https://www.smh.com.au/national/patent-fight-erupts-over-kakadu-plum-20101203-18jud.html

https://www.theguardian.com/sustainable-business/2017/may/26/protecting-thekakadu-in-kakadu-plums-selling-bush-foods-to-the-world#:~:text=In%20one%20 notable%20case%2C%20the,using%20the%20fruit%20for%20medicine

https://depws.nt.gov.au/\_\_data/assets/pdf\_file/0011/685676/kakadu-plum-treemanagement-program-2019-2023.pdf

https://kakaduplumco.com/pages/about

https://theconversation.com/meet-the-kakadu-plum-an-international-superfoodthousands-of-years-in-the-making-116362

#### **Student Learning Outcomes:**

By the end of the topic students can provide examples of traditional foods managed by First Nations Communities and can provide examples of how connection to Country and consumption of traditional foods has positive impacts on the health and nutrition of First Nations Communities.

#### Learning Activity:

Students will be introduced to concepts of food sovereignty through an international, national and local viewpoint using the example of Kakadu Plum.

#### **Assessment:**

Students to produce an infographic that focuses on the value of food sovereignty on First Nations Communities' health.

#### **Refer to the Framework:**

This example sits in the top triangle of the Framework and introduces the topic starting with the 'Australian' context before narrowing to' Regional' context and then to a 'Specific' context. This approach enables a teaching academic to create this curriculum without Community support.

#### Important Note on Depth of Knowledge Shared:

While it may be possible to access information on traditional foods used by First Nations Australians, the collection of foods on Country or detailed descriptions of using of these foods are not appropriate. For your legal obligations, refer to your

state heritage act. *Please see Resources for more information on the heritage acts.* You can bring the use of traditional foods into your curriculum by considering the implications for products that have been commercialised (as above). This could explore not only the environmental and nutritional benefits of growing traditional foods but could also be used to introduce the students to ICIP, as these foods have been grown by First Nations peoples for millennia. You could also explore the impacts of colonisation on First Nations Peoples through exploration of food sovereignty principles in this context.

### **Subject: Physics**

**Topic:** 

**Stress Waves** 

### **Tertiary Context:**



First Nations Australians have long used stone knapping to skillfully craft sharp blades. This blade is manufactured from silcrete. Image captured by J. Sambono

First Year 'In this unit, physics concepts such as mechanics, energy, fluids, waves, sound, electricity, optics, and atoms, will be explored. From: Deakin University, SLE123, accessed 2024. <u>https://www.deakin.edu.au/courses/unit?unit=SLE123</u>

### Aim:

To explore Primary-waves (P-waves) and Secondary-waves (S-waves) and showcase how First Nations Australians' knappers have long applied these ideas to control the fracturing of rocks.

### **Background Research:**

A teaching team researched the use of physics long used by First Nations Australians. Stone tool analysis had demonstrated that the shaping of stone tools like blades and spearheads were created through controlled fracturing of specific rock types using a hammerstone.

When the angle and force of a hammer stone is precise, kinetic energy in the form of waves is transferred from the hammer stone to the rock being knapped resulting in a controlled fracture. Skilled knappers systematically shape rock into desired forms like sharp edged stone tools. The propagation and interplay of stress waves through stone using knapping, provides a useful showcase to explore how P-waves (compressional waves) and S- Waves (shear waves) can create predictable and controlled breaks in materials.

#### **Resources:**

The Australian Museum, blogs <u>https://australian.museum/blog/science/knapping-and-archaeology-aboriginal-stone-tools-from-western-nsw/#:~:text=Many%20</u> of%20the%20tools%20were,of%20edges%2C%20was%20also%20used. YouTube, Aboriginal Wiradjuri stone tool making <u>https://www.youtube.com/</u> watch?v=luF1\_YgDvtM

### **Student Learning Outcomes:**

By the end of the topic students can explain the physics concepts related to P- and S- waves and how First Nations Australian have long employed understandings of fracture mechanics of rock in the development of stone knapping processes.

#### Learning Activity:

Students will be introduced to the physics of stress waves, through a showcase that identifies the underlying physics of stone knapping. Students will be shown a video, shared by a First Nations knowledge holder that demonstrates stone knapping. Students will propose ways in which P- and S-waves could be measured moving through different materials.

#### **Assessment:**

Students to produce a report that demonstrates their understanding of fracture mechanics and waves in solid materials such as rock, as applied by First Nations Australians' in the production of stone tools.

### **Refer to the Framework:**

This example sits in the top triangle of the Framework and introduces the topic focusing on the 'Australian' context and then to a 'Regional' context. This approach enables a teaching academic to create this curriculum independently.

#### Important Note on Depth of Engagement:

While it may be possible to access information independently on the method of stone knapping employed by First Nations Australians, the replication of the practice of stone knapping breaches First Nations Intellectual and Cultural Property (ICIP). In this case study, examples of (non-sacred/ceremonial) spear heads and blades can be highlighted from reputable sites in the public domain (museums), but you need the respective Communities consent before attempting to replicate traditional processes of stone quarrying, preparation, and knapping. This includes seeking to obtain a stone with evidence of stone knapping. It is also not appropriate to collect materials on Country. For your legal obligations, refer to your heritage acts. *Please refer to Resources:– Heritage Acts, for additional information.* You can bring the physics of First Nations Australians' stone knapping into your curriculum by using it as a cultural context by considering the propagation of waves and the transfer of forces associated with stone knapping without actually doing it.

### **Subject: Physics**

**Topic:** 

Levers

### **Tertiary Context:**



Stone axes have long been crafted by First Nations Australians. Image captured by J. Sambono

First year 'Engineering Physics'. 'The application of Newton's laws to a wide variety of phenomena will be investigated and the concepts of work, energy and the conservation laws discussed. Rotational kinematics and dynamics will be introduced, including the concepts of moment of inertia and torque.' From: Deakin University, SEB101, accessed 2024. <u>https://www.deakin.edu.au/courses-search/unit.php?unit=SEB101</u>

### Aim:

To explore Newton's laws and showcase how First Nations Australian have long applied these concepts in ingenious ways to the design and manufacture of spear throwers.

### **Background Research:**

A teaching team researched the use of levers by First Nations peoples around the world by consulting the Encyclopedia Britannica (48). They discovered that First Nations peoples from around the world have long used physics to create a diverse range of levers designed for specific purposes, for example hunting and fishing. Atlatl (spear-thrower) have long been used by the Mayans /Aztecs and the becket (sling) has long been used by the North African First Nations Peoples. Desktop research revealed that fundamental concepts of physics have long been used by First Nations Australians in the design of weapons (49) (50). Spear throwers, often referred to as a 'woomera', have been long used by First Nations Australian across specific regions of the continent, to increase the velocity of hand thrown spears (51).

Further research revealed that spear throwers are designed in a wide variety of shapes and sizes. For example, spear throwers used by the Kuuku I'yu Peoples in the Cape York Peninsula region are narrow, flat, and long (52). An education kit produced in collaboration with the Pitjantjatjara Peoples of northern South Australia provided approved photographs and details about design of their respective spear throwers (in language, *Miru*) that could be shared for education

purposes (53). They also found information and images on the South Australian Museum website.

The teaching team created a specific case study, showcasing Pitjantjatjara scientific knowledge of spear throwers by using it as a context, and comparing it to different levers. They approached spear throwing in general terms as an ingenious application of a lever ensuring they shared only facts in the public domain. They ensured all images and information were correctly attributed to the Pitjantjatjara peoples.

#### Resources

Please refer to Appendix D, which provides a detailed critical evaluation of the resources sourced for this case study.

#### **Student Learning Outcomes:**

By the end of the topic students can explain the physics concepts related to mechanical advantage, velocity and speed and explain how First Nations Australians' have long applied the laws of physics to maximise spear throwing accuracy and speeds.

### Learning Activity:

Students will explore the physics underpinning the application of the Miru as a lever.

### **Refer to the Framework:**

This example sits in the top triangle of the Framework and introduces the topic starting with the 'World' context, before narrowing down to the 'Australian', 'Regional' and then 'Specific' contexts. This approach enables a teaching academic to create this curriculum independently.

#### **Opportunities in the Bottom Triangle:**

There is an opportunity to expand the above case study into the bottom triangle of the Framework. For example, the teaching team may consider enriching their student's experience with a hands-on learning opportunity. There are examples of YouTube clips where a First Nations person demonstrates how to throw spears using a spear thrower. However, to investigate or replicate the specific technology and mechanics of a spear thrower, the teaching team would need to work in the bottom triangle and would therefore need to work in collaboration with the

respective First Nations Community to ensure they did not breach Indigenous Cultural and Intellectual Property (ICIP) protocols.

The teaching team could also consider inviting a willing First Nations Community representative to present to their class as a cultural expert (either in person or online). A lecture that showcased the application of a specific spear thrower would support their students understanding of the technology and help them to understand the underlying physics principles. The students would also have the privilege of learning directly from a First Nations expert. As a way of giving back, the teaching team could consider supporting their students to share their learning with the respective First Nations Community. It is also appropriate to remunerate First Nations knowledge holders for their time and expertise. Thus, the teaching team would need to explore funding opportunities to support their ideas to ensure they were fully prepared before reaching out to establish a relationship with a First Nations Community.

#### **Potential Future Learning Activity:**

With approval from and in collaboration with a respective First Nations Australian Community, students could investigate the speed and velocity of spears thrown with and without the aid of a spear thrower as they investigate the physics underpinning levers. It is also necessary to offer to remunerate First Nations knowledge holders for their time and expertise, or to work towards some mutually agreed upon exchange to recognise the value of the knowledge holder's contribution. It is important to keep in mind that knowledge holders may not want to engage.

#### **Assessment:**

Students could produce a report that demonstrates their ability to calculate acceleration and velocity using appropriate equations based on their hands on investigation of spear throwers.

### **Refer to the Framework:**

This example requires teaching teams to work in the bottom triangle of the Framework. If the respective First Nations Community agreed to collaborate and share their knowledge of the technology with the teaching team and students, then this would be a rich learning experience on many levels, and you would be

working in the deepest levels of the bottom triangle in an appropriate way. It is important to note that the Community may not be willing to collaborate and that is the Communities choice.

### Important Note on Depth of Engagement:

While it may be possible to access information from a museum, the replication of a spear thrower, including its culturally specific designs, shapes and dimensions breaches the First Nations Community's Intellectual and Cultural Property (ICIP). Being able to access a First Nations spear thrower either in person or via a website does not give you permission or the right to replicate the technology. In this case study the spear throwers are the Communities ICIP and therefore you need the Communities consent before exploring, investigating, researching, or replicating their technology.

### Note:

Educators may employ analogous levers to allow learners to experience the effects of leverage on throwing. For example, dog ball throwers are commercially available. Such equipment utilise the same physics principles but do not breach ICIP protocols.

### Subject: Geology

Topic

#### **Geological Field Methods**

### **Tertiary Context:**



Emu tracks on Mithaka Country. Image captured by J. Sambono

Third year 'Geological Field Methods.' 'This unit assumes knowledge of geological principles and methods, namely structural geology and basic petrology and petrography (sedimentary, igneous, and metamorphic rocks). It provides professional experiences that are essential for the employability for geology graduates.'

From: Queensland University of Technology, ERB305, accessed 2024. https://www.qut.edu.au/study/unit?unitCode=ERB305

#### Aim:

To support science students to develop 21<sup>st</sup> century cross-cultural science skills in their discipline of geology. Geology inherently requires fieldwork which in turn will require the negotiation of permissions to access lands and a deep awareness of the legal requirements of the care and protection of cultural heritage. Furthermore, geologists will need to consult and collaborate with respective Traditional Owners regarding the avoidance of sacred sites. These curriculum inclusions provide professional experiences that are essential for the employability of geology graduates, ensuring they are better prepared to work with and on the lands of First Nations Australians.

#### **Background Research:**

The teaching team aimed to provide students with learning experiences that combined the application of geological fieldwork and with the development of students' knowledge of First Nations Australians' ownership/management/comanagement of their respective lands, waters, and skies. Students learn about regulatory frameworks and moral obligations such as respect protocols, and the importance of ensuring consultation with Traditional Owners of the lands in which any geological work is undertaken.

#### **Resources:**

Please refer to Resources: Heritage Acts, for web links to state and territory heritage acts.

### **Refer to the Framework:**

This example sits in the top triangle and introduces the topic starting with the Australian context before narrowing down 'local' and 'specific' contexts. This approach enables a teaching academic to create this curriculum independently.

As the inclusion of opportunities for students to develop cross-cultural science skills (working With Us) in undergraduate curriculum programs is predominantly fact based (such as awareness of a scientists legal requirements or application of Respect Protocols), it is above the line and therefore within the scope of the top triangle. As such the teaching and learning of this content can be developed and delivered independently by the teaching team.

### **Student Learning Outcomes:**

By the end of this topic students demonstrate awareness of the following requirements prior to conducting field work. The teaching of these learning outcomes can be achieved through the simulation of real-world contexts in which students can theoretically demonstrate the application of the following:

• Identification of the relevant Traditional Owners for the land on which the geology field work is planned.

 Formal land access procedures and construction of agreements/partnerships/ protocols with respective First Nations Australian Agencies/Corporations/ Groups/Communities/Elders/knowledge holders.

Prior to conducting fieldwork that traverses or works on First Nations
 Australians' Country, adhere to relevant cultural heritage acts and their associated
 duty of care procedures.

### Learning Activity:

Students investigate the real-world requirements of a geological survey and write a report that models the diligence required in industry.

### Assessment:

Simulated geological survey, investigating mineral and petroleum deposits in Australia.

### **Cultural Protocols?**

• Podcast with Angelina Hurley, What are Cultural Protocols? <u>https://omny.fm/</u> <u>shows/cultural-protocols-nirs/what-is-cultural-protocols</u> accessed May 2024.

### **Cultural learning opportunities**

- AIATSIS Core Cultural Learning <u>https://aiatsis.gov.au/about/what-we-do/core-</u> <u>cultural-learning</u>
- Centre for cultural competence Australia <u>https://www.ccca.com.au/</u>
- To find where your knowledge fits in the process of developing cross cultural competence, refer to the Conscious Competence Learning Model: Taylor W.

 Conscious Competence Learning Model: BusinessBalls; 2024. Available from: <u>https://www.businessballs.com/self-awareness/conscious-competence-learning-model/</u>

• Australian Institute for Teaching and School Leadership (AITSL). Building a culturally responsive Australian teaching workforce 2024. Available from: <u>https://www.aitsl.edu.au/teach/cultural-responsiveness/building-a-culturally-responsive-australian-teaching-workforce</u>

• Australian Institute for Teaching and School Leadership (AITSL). Indigenous cultural responsiveness continuum 2024. Available from: <u>https://continuum.aitsl.</u> <u>edu.au/.</u>

### **Decolonising colonial narratives**

 Bellingham, R. A., & Fricker, A. (2024). Decolonising Australian Gold Rush Narratives with Critical Geopolitics. *Australian Journal of Environmental Education*, 1-14. <u>https://doi.org/10.1017/aee.2024.34</u> (54).

### First Nations Community engagement models

• Department of Premier and Cabinet Victoria. First Peoples - State Relations Group. Guidance on Engaging Traditional Owners <u>https://www.</u> <u>firstpeoplesrelations.vic.gov.au/engaging-traditional-owners</u> (55).

### **First Nations science**

• Cajete, G. 1999. Igniting the Sparkle: An Indigenous Science Education Model. Kivaki Press (25).

### Heritage acts

- Australian Capital Territory <u>https://www.environment.act.gov.au/heritage/</u> <u>heritage-registration-and-protection</u>
- North Territory https://legislation.nt.gov.au/Legislation/HERITAGE-ACT-2011
- Queensland <u>https://www.dsdsatsip.qld.gov.au/our-work/aboriginal-torres-strait-</u> islander-partnerships/culture/aboriginal-torres-strait-islander-cultural-heritage
- South Australia <u>https://www.agd.sa.gov.au/aboriginal-affairs-and-</u> reconciliation/aboriginal-heritage/about-aboriginal-heritage-in-south-australia
- Tasmania <u>https://www.aboriginalheritage.tas.gov.au/learn/awareness/index.</u>
   <u>html.1.10.html</u>
- Victoria -<u>https://www.legislation.vic.gov.au/in-force/acts/aboriginal-heritage-</u> act-2006/027
- Western Australia <u>https://www.wa.gov.au/organisation/department-of-</u> planning-lands-and-heritage/aboriginal-heritage-act-western-australia

# Historical explanation of science, and science as an epistemological position

 The knowledge has been modified to fit with contemporary epistemology, value systems, and ways of knowing: Aikenhead, G., & Michell, H. (2011). Bridging cultures: Indigenous and scientific ways of knowing nature. In: Toronto, ON: Pearson Canada Inc (12).

• Contemporary science has developed over time from non-European cultures such as Islamic and Eastern cultures: Ball, R. (2015). STEM the gap: Science belongs to us mob too. *The Australian quarterly*, 13-19 (56).

• Masakata Ogawa proposed that there are "multisciences" (1995, p. 584) where all cultures have a science or rational and empirical ways of describing phenomena: Ogawa, M. (1995). Science education in a multiscience perspective. *Science education*, 79(5), 583-593 (30).

### **Indigenous Cultural Intellectual Property**

- Terri Janke and Company may help universities to form ICIP protocols, agreements, and provide workshops on ICIP. More information is available at <a href="https://www.terrijanke.com.au/">https://www.terrijanke.com.au/</a>
- Janke T. True tracks: Respecting Indigenous knowledge and culture: UNSW Press; 2021. <u>https://www.terrijanke.com.au/resources</u> (57).
- National Library of Australia. Australian Indigenous Cultural & Intellectual Property (ICIP) Protocol 2023. Available from: <u>https://www.nla.gov.au/sites/</u> <u>default/files/2023-09/nla-icip-protocol-2023.pdf</u> (58).
- University of Newcastle. Aboriginal and Torres Strait Islander Cultural and Intellectual Property Protocol 2023. Available from: <u>https://www.newcastle.edu.</u> <u>au/our-uni/indigenous-commitment/indigenous-cultural-and-intellectual-property-</u> <u>protocol</u> (59).

### **Positionality prompts**

Positionality has an impact on how to use this framework. Consider your positionality using these prompts:

- How do you understand yourself in relation to others in Western society and your society if different?
- How do you view science in the educational context, and do you see it as being reflective of a particular worldview?
- · Do you think science prioritises a particular cultural perspective?
- What motivations do you have for wanting to add First Nations sciences to your unit content?
- How do you understand your position in relation to your local First Nations Community?

### Using reflection as assessment

- · Assess the reflective process not the content of the reflection.
- Decide on the assessment criteria and the reflective model to use.
- Ensure the assessment criteria includes an item on being respectful.
- Assess how the student followed the reflective process and met the assessment criteria.

### Relationality

Relationality is a term that can describe the relational learning process of research and academia. This process emphasises the importance of relationships between the researcher, the participants, and the broader community. It acknowledges the interconnectedness of all living things and the environment. The concept of relationality pairs academic literature with stories and lessons from Country.

### **Respectful language**

• Australian Government Style Manual. Aboriginal and Torres Strait Islander peoples. N.D. <u>https://www.stylemanual.gov.au/accessible-and-inclusive-content/</u> inclusive-language/aboriginal-and-torres-strait-islander-peoples (60).

 Australian Institute of Aboriginal and Torres Strait Islander Studies. Indigenous Australians: Aboriginal and Torres Strait Islander people. N.D. Available from: <u>https://aiatsis.gov.au/explore/indigenous-australians-aboriginal-and-torres-strait-islander-people</u> (61).

### Teaching and curriculum resources

AIATSIS curriculum resources, <u>https://aiatsis.gov.au/education/curriculum-</u>
 <u>resources</u>

• AIATSIS guide to evaluating and selecting education resources, <u>https://aiatsis.</u> gov.au/education/guide-evaluating-and-selecting-education-resources

• AIATSIS Language Map of Australia, <u>https://aiatsis.gov.au/explore/map-indigenous-australia</u>

• Australian Curriculum: Science Aboriginal and Torres Strait Islander Histories and Cultures cross-curriculum priority:

 Content elaborations and teacher background information for Foundation to Year 6 <u>https://www.australiancurriculum.edu.au/</u> <u>media/5653/ccp-tbi-f-6-ver5-online.pdf</u>

Content elaborations and teacher background information for Years

7-10 https://www.australiancurriculum.edu.au/media/5086/ccp-tbi-7-10.pdf

Lecturer guidebook, Cultural responsiveness and First Nations student
 engagement, <u>https://firstnationssuccess.cdu.edu.au/wp-content/uploads/2024/09/
 Lecturer-Guidebook.pdf</u>

 Indigenous Archives Collective: Faulkhead ST, K; Sentance, N; Booker, L; & R Barrowcliffe,. Indigenous referencing guidance for Indigenous knowledges / CAVAL & the Indigenous Archives Collective. Indigenous Referencing Guidance for Indigenous Knowledges. Indigenous Archives Collective and the UTS Jumbunna Institute of Indigenous Education and Research.; 2023. CC BY-NC-SA 4.0 (37).

Ngarrngga curriculum resources and professional development, <u>https://www.</u>
 ngarrngga.org/

# References

(1) Ngarrngga, Narrangunnawali. Reconciliation and Education: Past-Present-Future Forum Summary Report. 2024.

Australian Council of Deans of Science. Science threshold learning outcomes 2024 [Available from: <u>https://doi.org/10.1007/</u> s11422-007-9067-8.

(2) Department of Industry S, and Resources, Australia's National Science and Research Priorities. 2024.

(3) Australian Council of Deans of Science. Science threshold learning outcomes 2024 [Available from: <u>https://doi.org/10.1007/s11422-007-9067-8.</u>

(4) Price K. Aboriginal and Torres Strait Education: an introduction for the teaching profession. Port Melbourne: Cambridge University Press; 2015. p. 164-8.

(5) Holloway-Clarke T. What is positionality? 2024 [Available from: <u>https://www.commonground.org.au/article/what-is-</u> positionality.

(6) Department of Education. Australian Universities Accord Final Report. Department of Education; 2024.

(7) Universities Australia. Universities Australia's Indigenous Strategy 2022-2025. 2024.

(8) Cunningham A, Williams P. De-centring the 'big picture': The Origins of Modern Science and the modern origins of science. The British journal for the history of science. 2009;26(4):407-32.

(9) Chalmers AF. What is this thing called science?: Hackett Publishing; 2013.

(10) Johnson JT, Howitt R, Cajete GA, Berkes F, Louis RP, Kliskey A. Weaving Indigenous and sustainability sciences to diversify our methods. Sustain Sci 2016;11:1-11.

(11) Stephens S. Handbook for culturally responsive science curriculum. Fairbanks, Alaska: Alaska Native Knowledge Network; 2003.

(12) Aikenhead G, Michell H. Bridging cultures: Indigenous and scientific ways of knowing nature. Toronto, ON: Pearson Canada Inc; 2011.

(13) Tsuji LJ, Ho E. Traditional environmental knowledge and western science: in search of common ground. . Canadian Journal of Native Studies. 2002;22(2):327-60.

(14) Battiste M. Indigenous Knowledge and Pedagogy in First Nations Education Ottawa, ON: Indian and Northern Affairs Canada (INAC); 2002 [Available from: <u>https://www.nipissingu.ca.</u>

(15) Sambono J. "The Aboriginal and Torres Strait Islander Histories and Cultures Cross-curriculum Priority: Cultural responsiveness in science education". . SASTA Journal. 2021;1.

(16) Australian Human Rights Commission. National Anti-Racism Framework Scoping Report 2022. 2022.

(17) Page S, Trudgett M, Bodkin-Andrews G. Creating a degree-focused pedagogical framework to guide Indigenous graduate attribute curriculum development. Higher Education. 2019;78(1):1-15.

(18) Norris R. "Aboriginal people – how to misunderstand their science". . The Conversation. 2014 21 April 2014.

(19) United Nations. United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP). 2024 25 June 2024.

(20) UNESCO. Inclusion in education: UNESCO; 2023 [Available from: <u>https://www.unesco.org/en/inclusion-</u>education.

(21) United Nations. Department of Economic and Social Affairs Sustainable Development 2024 [Available from: <u>https://sdgs.un.org/goals.</u>

(22) WIPO World Intellectual Property Organization. WIPO Treaty on Intellectual Property, Genetic Resources and Associated Traditional Knowledge. 2024 24 May 2024.

(23) Universities Australia. Universities Australia's Indigenous Strategy 2017-2020,. 2024.

(24) Deakin University. Deakin Indigenous Strategy 2023-2028: Deakin University; 2023 [Available from: <u>https://www.deakin.</u> <u>edu.au/indigenous-students.</u>

(25) Cajete GA. Igniting the Sparkle: An Indigenous Science Education Model: ERIC; 1999.

# References

(26) ACARA. Australian Curriculum: Science Aboriginal and Torres Strait Islander Histories and Cultures cross-curriculum priority 2019.

(27) Harding S. Is science multicultural? Challenges, resources, opportunities, uncertainties. Configurations. 1994;2(2):301-30.

(28) Michie M. Why Indigenous science should be included in the school science curriculum Australian Science Teachers Journal. 2002;48(2):36-40.

(29) Nakata M. The Cultural Interface. The Australian Journal of Indigenous Education. 2007;36:7-14.

(30) Ogawa M. Science education in a multiscience perspective. Science education. 1995;79(5):583-93.

(31) First Nations Education Steering Committee. Science First Peoples teacher resource guide. First Nations Education Steering Committee and First Nations Schools Association; 2016.

(32) Aikenhead GS, Ogawa M. Indigenous knowledge and science revisited. Cultural Studies of Science Education. 2007;2(3):539-620.

(33) Battiste M, Henderson SKJ. Indigenous and Trans-Systemic Knowledge Systems. Engaged Scholar Journal. 2021;7(1):i-xix.

(34) Janke T. Rights to culture Indigenous Cultural and Intellectual Property (ICIP) Copyright and Protocols.: Terri Janke and Company. ; 2018.

(35) Indigenous Archives Collective: Faulkhead ST, K; Sentance, N; Booker, L; & R Barrowcliffe,. Indigenous referencing guidance for Indigenous knowledges / CAVAL & the Indigenous Archives Collective. Indigenous Referencing Guidance for Indigenous Knowledges. Indigenous Archives Collective and the UTS Jumbunna Institute of Indigenous Education and Research.; 2023

(36) Food and Agriculture Organization of the United Nations. Respecting free, prior and informed consent.; 2014.

(37) Janke T. In conversation: Dr Terri Janke: Reconciliation Australia; 2021 [Available from: <u>https://www.reconciliation.org.</u> au/in-conversation-dr-terri-janke/.

(38) Indigenous Archives Collective: Faulkhead ST, K; Sentance, N; Booker, L; & R Barrowcliffe,. Indigenous referencing guidance for Indigenous knowledges / CAVAL & the Indigenous Archives Collective. Indigenous Referencing Guidance for Indigenous Knowledges. Indigenous Archives Collective and the UTS Jumbunna Institute of Indigenous Education and Research.; 2023

(39) Milroy J. Indigenous Engagement with Science: Towards deeper understandings. Department of Industry Innovation and Science; 2013.

(40) Convention on Biological Diversity. The Nagoya Protcol on Access and Benefit-sharing 2024 [<u>Available from: https://</u> www.cbd.int/ABS.

(41) Tertiary Education Quality and Standards Agency. Higher Education Standards Framework. 2021.

(42) Uleanya C. Hidden curriculum versus transition from onsite to online: A review following COVID-19 pandemic outbreak. . Cogent Education. 2022;9(1).

(43) Australian Curriculum. Investigating the effect of forces through the application of simple machines, such as the bow and arrows used by Torres Strait Islander Peoples or the spearthrowers used by First Peoples of Australia. 2019 [Available from: <u>https://v9.australiancurriculum.edu.au/teacher-resources/background-information/science\_teacher\_background\_</u> *information\_AC9S7U04\_E8*.

(44) Australian Bureau of Meteorology. Australian Climate Influences 2024 [Available from: <u>http://www.bom.gov.au/climate/</u> <u>about/.</u>

(45) Wilson A, Wilson R, Delbridge R, Tonkin E, Palermo C, Coveney J, et al. Resetting the Narrative in Australian Aboriginal and Torres Strait Islander Nutrition Research. Current developments in nutrition. 2020;4(5).

(46) Australian Government. State of the Environment 2021.

# References

(47) Newton JS. The oldest foods on earth: a history of Australian native foods with recipes. : New South Publishing; 2016.(48) The Editors of Encyclopaedia Britannica. Spear-thrower. Encyclopedia Britannica2024.

(49) Langley M, Diamond L. First-ever biomechanics study of Indigenous weapons shows what made them so deadly. : The Conversation; 2024 [Available from: *https://theconversation.com/first-ever-biomechanics-study-of-indigenous-*

weapons-shows-what-made-them-so-deadly-239936?utm\_medium=email&utm\_campaign=Latest%20from%20The%20 Conversation%20for%20October%2030%202024%20-%203149132097&utm\_content=Latest%20from%20The%20

Conversation%20for%20October%2030%202024%20-%203149132097+CID\_e8f393da52ec7b0e8f14dd1137697527&utm\_ source=campaign\_monitor&utm\_term=First-ever%20biomechanics%20study%20of%20Indigenous%20weapons%20 shows%20what%20made%20them%20so%20deadly.

(50) Diamond LE, Langley MC, Cornish B, Pizzolato C, Saxby DJ. Aboriginal Australian weapons and human efficiency. . Scientific Reports. 2024;14.

(51) Cundy BJ. Formal variation in Australian spear and spear-thrower technology 1980 [Available from: <u>https://catalogue.</u> <u>nla.gov.au/catalog/1848686</u>.

(52) Kuuky I'yu in Dearden M. Links to the past: Woomera from central Cape York Peninsula, Flinders University, College of Humanities, Arts and Social Sciences 2021 [Available from: <u>https://flex.flinders.edu.au/file/1ef6eafa-03c4-4c3d-8af4-</u>744f99d088e0/1.

(53) Maruku. PunukuTjukurpa Education Kit 2024 [Available from: <u>https://maruku.com.au/wp-content/uploads/sites/19/</u> <u>PunukuTjukurpa\_EducationKit.pdf</u>.

(54) Bellingham RA, Fricker A. Decolonising Australian Gold Rush Narratives with Critical Geopolitics. Australian Journal of Environmental Education. 2024:1-14.

(55) Department of Premier and Cabinet Victoria. First Peoples - State Relations Group. Guidance on Engaging Traditional Owners N.D. [Available from: https://www.firstpeoplesrelations.vic.gov.au/engaging-traditional-owners.

(56) Ball R. STEM the gap: Science belongs to us mob too. The Australian quarterly. 2015:13-9.

(57) Janke T. True tracks: Respecting Indigenous knowledge and culture: UNSW Press; 2021.

(58) National Library of Australia. Australian Indigenous Cultural & Intellectual Property (ICIP) Protocol 2023 [Available from: https://www.nla.gov.au/sites/default/files/2023-09/nla-icip-protocol-2023.pdf.

(59) University of Newcastle. Aboriginal and Torres Strait Islander Cultural and Intellectual Property Protocol 2023 [Available from: <u>https://www.newcastle.edu.au/our-uni/Indigenous-commitment/Indigenous-cultural-and-intellectual-</u> property-protocol.

(60) Australian Government Style Manual. Aboriginal and Torres Strait Islander peoples. N.D.

(61) Australian Institute of Aboriginal and Torres Strait Islander Studies. Indigenous Australians: Aboriginal and Torres Strait Islander people. N.D. [Available from: <u>https://aiatsis.gov.au/explore/indigenous-australians-aboriginal-and-torres-</u> <u>strait-islander-people</u>.

(62) Horton DR. Aboriginal Australia Map: Aboriginal Studies Press AIATISI and Auslig/Sinclair, Knight, Merz; 1996 [Available from: https://aiatsis.gov.au/explore/map-indigenous-australia.

# **Appendix A**

### **About the Authors**

### Jordan Ah Chee

My name is Jordan Ah Chee, and I am a proud Bindjareb/Paylku man on my mother's side, and Yawuru/Nyikina man on my father's side. I am a lecturer for the School of Indigenous Knowledges at Murdoch University, teaching Two-Way Science, with a background in Physics. I work towards ensuring that students at Murdoch develop their understanding and appreciation of Indigenous knowledge systems in STEM, to give them the tools to work respectfully and ethically in their careers, and to support the next generation of First Nations scientists.

### **Rebecca Bennett**

I am a researcher, educator, and senior leader with a passion for social justice and social equity in education. I have been working closely with Indigenous knowledge-holders, academics, students, and community in a university Indigenous Education Unit for several years. I am committed to amplifying Indigenous ways of knowing, being and doing within the university sector, and to ensuring their place as equal, and often superior, approaches for understanding the world and its peoples.

### **Connie Cirkony**

I was born in Winnipeg on Treaty One Territory as a second generation Canadian with Eastern European ethnicity. I was the first in my family to graduate from high school and went on to study biology in university, eventually completing graduate degrees in science and environmental education. My early career as a biologist continues to inform how I approach science education – with many parallels with First Nations knowledge systems. As a non-Indigenous ally, I believe that bringing together different worldviews enriches how we teach and practice science to support meaningful learning as well as an equitable and sustainable future for all.

### **Karla Coutts**

I am an educator, education developer, and social researcher. I have been working in First Nations STEM curriculum at Deakin University for over five years, in partnership with First Nations people, unit chairs and Heads of School to include

# **Appendix A**

First Nations cultures and histories appropriately as part of what we do in STEM every day.

### Laura Fairbrother

I am a teacher, a curriculum developer, and a researcher. I am committed to enhancing quality in education, and I believe we need to design curriculum with the people who are impacted by it the most. I have a special interest in building staff capability to ensure we have the mindsets, skillsets, and toolkits to create quality education for all our students.

### **Tiffany Gunning**

I am a biochemist/plant pathologist, educator and researcher who specialises in STEM curriculum development and academic professional development. I have a particular interest in ensuring our students experience authentic learning opportunities that prepare them to be informed and ethical global citizens. While developing my own cultural intelligence, I encourage academics to do same, so that they can consciously and respectfully include Indigenous knowledges into their curriculum.

### **Tui Raven**

I am Yamaji Nyungar and Senior Manager Indigenous Programs, Deakin Library. In 2023 I authored the Guidelines for First Nations Collection Description a joint project between AIATSIS, ALIA, CAUL, CAVAL and NSLA. I am also a consultant art curator, researcher, and cultural advisor. From 2020 to 2022, I also played a crucial role in The First Inventors documentary series. The Australia Research Council Centre of Excellence for Australian Biodiversity and Heritage (CABAH) was the principal research partner for the series. I worked as on-Country advisor, associate producer, and co-investigator.

### Joe Sambono

I am a Jingili man with familial ties across the Northern Territory, Queensland, and Western Australia. My cultural background and academic expertise in Zoology (BSc, James Cook University) and Education (BEd, University of Queensland) equips me to merge my cultural, scientific and education expertise with a passion for transforming Australia's education system.

# **Appendix A**

As a Professor of Practice in Indigenous Australian Perspectives at Queensland University of Technology, I focus on embedding First Nations knowledge systems and cultural perspectives into educational curricula. This work builds on my leadership experience with national curriculum initiatives at CSIRO and the Australian Curriculum, Assessment, and Reporting Authority (ACARA). In addition, I serve as an expert advisory panel member for Ngarrngga, an initiative connecting Australian students with Aboriginal and Torres Strait Islander knowledge systems and cultural heritage. I am deeply committed to driving systemic change that ensures the recognition and inclusion of First Nations Australians' histories and cultures throughout Australia's education systems.

### L-J Singh

I am Laura-Jane Phoenix Singh, a proud Quandmooka and Wiradjuri woman; I am a mother, a tidda, a sister and a friend. I am strong in culture, proud of my Community and working hard to make a change. I am employed at Deakin University as the Associate Head of School (Indigenous Engagement) within Life and Environmental Sciences. My professional expertise centres on sociology, First Nations knowledge systems, curriculum development and the intersection between science, education, and health promotion.

### **Bep Uink**

I am a Noongar woman and Senior Research Fellow at Kulbardi Aboriginal Centre, Murdoch University. My research focuses on understanding how socially determined disadvantage impacts the social and emotional wellbeing of young people, both Indigenous and non-Indigenous, and how social systems can support them.

### Angela Ziebell

I am a chemist, educator, and STEM education researcher with a special interest in preparing graduates for life after university. In Australia that includes having cultural intelligence around Indigenous knowledges therefore I also started working to bring Indigenous knowledges to students while working to understand both the teacher and educator experience of teaching/learning about Indigenous knowledges.

# **Appendix B**

### What does ICIP mean for educators?

When showcasing First Nations Australians' cultures and histories, we, as educators, are in fact actively incorporating Indigenous Cultural and Intellectual Property (ICIP) by identifying contexts within First Nations knowledge and knowledge systems that are relevant to tertiary science. Indigenous knowledges and knowledge systems include scientific, agricultural, technical, ecological and ritual knowledge and are a core component of ICIP.

By understanding ICIP you can include First Nations Australians' cultures and histories in a manner that is both appropriate and respectful. Respecting ICIP rights in teaching and learning involves, at a minimum, acknowledging the ownership of the intellectual property being showcased. An educator's role is not to teach or express culture in depth but to showcase First Nations excellence, and to highlight First Nations science legitimacy and value. As part of the educator's role, there is an expectation to demonstrate due diligence when including First Nations cultures and histories into their teaching, ensuring respect, care and consideration for ICIP rights.

This Framework does not endorse free access and use of all First Nations cultures and histories. When it comes to education and teaching it is essential to refer to existing guides. *Please refer to Resources: Indigenous Cultural and Intellectual Property, for additional information.* 

### **ICIP Attribution**

Attributing First Nations Australians' ICIP is a fundamental practice that all educators should incorporate as a minimum standard of academic integrity. Providing accurate attribution offers much-needed and long-overdue formal recognition to those whose ICIP is being used, while also ensuring that the cultural diversity of Australian First Nations is not overlooked, masked or denied. Where possible, attribution should specifically acknowledge the Community and/ or individual whose ICIP is represented in the teaching material, using cultural warnings where appropriate, and ensuring acknowledgements are prominently placed within teaching and learning materials.
## **Appendix B**

The ICIP continuum illustrated in Figure 6, demonstrates the range of practices and levels of engagement that students, educators, curriculum developers and researchers must consider when attributing ICIP to the appropriate First Nations Communities or authors. The way ICIP is used in an educator's work depends on their role. For example, a curriculum developer can use sanctioned resources to determine the best sources for curriculum content, and decide whether to partner with others to ensure correct attribution of First Nations Australians' cultures and histories. A teacher must understand how to assess whether a student's attribution is correct and also correctly attribute learning materials. Researchers are required to obtain explicit Community engagement and collaboration through formal IP and/or ICIP agreements. However, in undergraduate teaching areas, where ICIP may be showcased, it is recommended to recognise ICIP rights attributing First Nations peoples, Communities or authors.



#### Figure 6 ICIP continuum

Educators can apply strong ICIP protocols with minimum effort. For example, historically educators would often refer to a cultural practice of a particular group as simply 'Aboriginals use a woomera to hunt animals.' Today, however, educators increasingly recognise the offensiveness of homogenising and failing to accurately attribute cultural practices or technologies to the respective owners. Instead, they would state the following, 'Pitjantjatjara men of central Australia, have long employed a spear thrower known as a miru, to hunt kangaroo.' This example specifies the particular Community rather than generalising to all First Nations Australians. It is important to note that much of the early literature about First Nations Australians has masked the diversity and ownership of the ICIP.

## **Appendix B**

However, with little effort, by consulting the AIATSIS map, the geolocation of the original source may identify the language, Country and People, and ICIP owners may be identified (62).

Available at https://aiatsis.gov.au/explore/map-indigenous-australia

The Framework section will assist you to determine the involvement with First Nations Communities needed in your curriculum development.

By showcasing First Nations Australians' cultures and histories in science curricula, you are promoting cultural diversity and inclusion in your teaching. By applying the principles of ICIP, you demonstrate to students how to be respectful and inclusive of both First Nations and non-First Nations science in the curriculum.



First Nations Australians on the eastern sea board have long extracted antibacterial agents from Melaleuca alternifolia (tea tree) and applied bark to cover and treat wounds. Image captured by J. Sambono

## Appendix C

### The First Nations Australian science continuum

Continuum by Sambono, J. 2021.

Forming mutually beneficial collaborations with First Nations Australians in science that ensures free, prior informed consent and ndigenous Cultural and Intellectual Property rights are protected Appropriately consulting First Nations Peoples and their knowledges in science. protect and develop their intellectual property over traditional knowledge and Respecting their right to maintain, control, cultural expressions. society and how the rights of Indigenous Peoples in controlling and maintaining and future contributions to science and their sciences, technologies and cultures Recognising historical, contemporary nave not always been respected. Awareness of examples of First Nations Australians long history of working scientifically in the development of specific knowledges, technologies and processes including their application of diverse science concepts. Australians continuing Acknowledging First Nations knowledges as valid and valuable repositories of information. Blindness, denial or exclusion of First Nations

FIRST NATIONS AUSTRALIAN SCIENCE CONTINUUM

75

Peoples science.

# Using the IKAT to support how to evaluate resources

The Indigenous Knowledges Attribution Toolkit (IKAT) is a citing and referencing toolkit that provides guidance on critically analysing content and attributing First Nations knowledges and authorship within academic referencing practices (p5) (35). *Please refer to Framework for Educators, Section B. Curriculum Development Support for further information.* 

While the intent of the IKAT is to encourage undergraduate students to include referencing relevant to First Nations knowledges and authorship, it can be used by academics as a tool for critical analysis to aid with evaluating resources. The work below was developed through the application of the IKAT. It is grounded in a real-world experience of investigating content for inclusion in tertiary science curriculum. It works through the process of:

- · Locating and critically analysing a range of resources.
- Considering the correct attribution of First Nations knowledges.
- Using the Framework template to support curriculum design.

The following illustrates how the IKAT provided independent guidance to the development of a First Nations Australians' context (Subject: Physics Topics: Levers) and the navigation and considerations required when accessing the information available in the public domain. For example, researching Australian First Nations knowledges related to physics, will unearth a wide range of text types ranging from colonial archives, news reports, social media and scientific journals.

### Locating resources

Locating useful and appropriate curriculum resources can be achieved via desktop research. Entering search terms into a search engine or using generative artificial intelligence can help to get you started. For example, entering "Australian First Nations knowledges related to physics" into an online search engine will return a range of resources from a range of websites, including museums,

Australian Curriculum documents, CSIRO, universities and videos. If you seek scholarly based research, starting with a dedicated online scholarly search engine like Google Scholar or Semantic Scholar would be appropriate. You can then narrow your search to be more specific. For example, "Australian First Nations knowledges related to spear throwers". Another useful place to start is the reference section of recent literature or literature reviews. Research journals, master's and PhD thesis', books and curriculum plans that focus on your topic of interest contain a wealth of primary and secondary resources.

Of note is the First Knowledges book series edited by Margo Ngawa Neale (Gumbaynggirr and Wiradjuri), Senior Indigenous Curator at the National Museum of Australia. This series provides an introduction to Indigenous knowledges across a range of topics (including plants, land management, design, astronomy, and health) and explores the deep understanding of the expertise, wisdom, ingenuity and application of these knowledges to the present day and the future. The series is a useful resource for expanding your cultural competency and provides an extensive reference list that can be explored for designing curriculum.

Other valuable sources of information are current affairs news sites, including NITV, ABC, The Conversation and social media platforms, such as YouTube. Regardless of how you conduct your research, resources must be critically analysed and correctly attributed. The IKAT is highly recommended for this purpose <u>https://www.caval.edu.au/referencing-toolkit/</u>.

### Analysis of resources

### **Tertiary Sources**

Compilation or summary of primary and secondary sources (examples include encyclopedias, fact books, databases, and textbooks).

#### **Secondary Source**

A non-First Nations person's interpretation of the primary source (examples include documentary, biography, review analysis of primary data, commentary on a primary source).

### **Primary Source**

First-hand account provided by a First Nations person is direct evidence (examples include audio, video, interviews, original documents and artefacts).

### **Examples of Tertiary Sources**

### **Encyclopedia Britannica**

The Editors of Encyclopaedia Britannica. Spear-thrower. Encyclopedia Britannica. 13 June 2024 <u>https://www.britannica.com/technology/spear-thrower</u> Accessed 2024.

The Encyclopedia Britannica content was analysed, noting it provided information that was general in nature, used respectful language and recognised the spearthrower as technology/mechanical engineering. Authorship was stated as the 'editors' and, therefore, had no links to First Nations authors.

**Outcome:** This resource could form the basis of an introduction only to a world context. While the resources can be critically analysed, it is not possible to cite and reference specific First Nations People's, Country, Nation or Language.

### Australian Curriculum Assessment and Reporting Authority

Australian Curriculum. Investigating the effect of forces through the application of simple machines, such as the bow and arrows used by Torres Strait Islander Peoples or the spearthrowers used by First Peoples of Australia.

Australian Curriculum; 2019 v9, <u>https://v9.australiancurriculum.edu.au/teacher-</u> resources/background-information/science\_teacher\_background\_information\_ <u>AC9S7U04\_E8</u> Accessed 2024.

This Australian Curriculum Assessment and Reporting Authority (ACARA) resource was researched and constructed by and in collaboration with First Nations science experts and explores and celebrates scientific knowledges of Australia's First Nations Peoples. This resource also provided the consulted works, which enabled access to the original sources for further exploration and evaluation.

**Outcome:** This resource could be used to inform the basis of a lesson plan, and the reference list used to explore the topic more deeply. While the resources can be critically analysed, it is not possible to cite and reference specific First Nations People's, Country, Nation or Language.

#### **Mylearning website**

Multi-purpose Gadget to Cut, Carry or Throw, <u>https://www.mylearning.org/stories/</u> <u>australian-aboriginal-spear</u> Accessed 2024 (56).

The 'mylearning.org' website used language that was not always appropriate or respectful of Australia's First Nations peoples scientific achievements, and it also cited Wikipedia as its reference source, which is not reliable.

**Outcome:** This resource was **REJECTED** and considered inappropriate, due to language and referencing concerns.

### **Examples of Secondary Sources**

### **Book from the National Library collection**

Cundy B.J. Formal variation in Australian spear and spear-thrower technology, 1980. *https://catalogue.nla.gov.au/catalog/1848686* Accessed 2024.

This is an older resource (40 years), and the research was conducted by a non-First Nations researcher whose research was based on artefacts and films held in museum archives and referenced works from non-First Nations authors. The research utilised images and film to investigate the physics/technology underpinning the spear thrower.

When referring to artefacts, the author provided the respective locations, for example, 'The film contains three sequences of M. Edwards of the Edward River (Cape York) throwing a spear with a spear thrower.' This information may help to identify the respective Place/Nation/Country/Language group, which can be used to clarify First Nations knowledge contribution. While some language used in this resource is no longer appropriate, it values First Nations ingenuity and was respectful in tone.

**Outcome:** The resource was considered valuable, noting that if quoting from this source, some language may need to be updated. While the resource can be critically analysed, it is not possible to cite and reference specific First Nations People's Country, Nation or Language, by just investigating the text.

#### Further research related to First Nations knowledges:

To further improve the use of this material, providing context to the First Nations knowledges cited in the resources would be appropriate. For example, some further critical analysis related to Mr M. Edwards from Cape York may be warranted. The Queensland Government website revealed that the Community near Edward River is called Pormpuraaw and is located on the lands of the Thaayore People. As a former mission, it was home to Thaayore, Wik, Bakanh and Yir Yoront Peoples. To expand the students' cultural competency, this information should be shared with students and could be accompanied by the AIATSIS map of Indigenous Australia, <u>https://aiatsis.gov.au/explore/map-indigenous-australia</u>.

Note when sharing the map you must ensure correct attribution and provide the link to the map that resides on the AIATSIS website. The students may not be able to provide Nation/Language/Country as part of their citation and referencing (as per the IKAT). However, you have provided them with skills to understand and critically analyse resources.

Horton DR, creator. Aboriginal Australia Map © Aboriginal Studies Press, AIATSIS and Auslig/ Sinclair, Knight, Merz, 1996, <u>Available at https://aiatsis.gov.au/explore/</u> map-indigenous-australia.

#### Woomera research from a university:

Dearden M. Links to the past: Woomera from central Cape York Peninsula. Flinders University; 2021, <u>https://flex.flinders.edu.au/file/1ef6eafa-03c4-4c3d-8af4-744f99d088e0/1</u> Accessed 2024.

This research was conducted by a non-First Nations researcher who collaborated with Kuuku I'yu People of central northern Cape York Peninsula. The author aimed to support First Nations people to reconnect with this aspect of cultural ancestry and used respectful language.

**Outcome:** This resource was considered valuable and appropriate for use and can be referenced using the IKAT (First Nations knowledges as cited by non-First Nations authors), (see below).

Kuuky I'yu in Dearden M. Links to the past: Woomera from central Cape York Peninsula. Flinders University; 2021. <u>https://flex.flinders.edu.au/file/1ef6eafa-03c4-4c3d-8af4-744f99d088e0/1/Dearden%202020\_Master%20Copy.pdf</u> Accessed 2024.

#### **Current Affairs Article based on Academic Literature:**

'The Conversation' is another useful site that produces content in collaboration between academics and journalists. The editors 'turn knowledge and insights from academics into easy-to-read articles and make them accessible to readers'. <u>https://theconversation.com/au/who-we-are</u> Accessed 2024.

Langley, M and Diamond, L. First-ever biomechanics study of Indigenous weapons shows what made them so deadly. The Conversation 2024. https://theconversation.com/first-ever-biomechanics-study-of-indigenousweapons-shows-what-made-them-so-deadly-239936?utm\_medium=email&utm\_ campaign=Latest%20from%20The%20Conversation%20for%20October%20 30%202024%20-%203149132097&utm\_content=Latest%20from%20The%20 Conversation%20for%20October%2030%202024%20-%203149132097+CID\_ e8f393da52ec7b0e8f14dd1137697527&utm\_source=campaign\_monitor&utm\_ term=First-ever%20biomechanics%20study%20of%20Indigenous%20weapons%20 shows%20what%20made%20them%20so%20deadly Accessed 2024.

This Conversation resource was based on the following scientific journal article, Diamond, L.E., Langley, M.C., Cornish, B. et al. Aboriginal Australian weapons and human efficiency. Sci Rep 14, 25497 (2024) <u>https://doi.org/10.1038/s41598-024-76317-w</u>. This research team conducted a biomechanical analysis of the application of weapons, featured in the ABC Education series First Weapons (see evaluation and attribution in Primary Sources). This public science series explores Indigenous Australian weapon innovation.

While the authors are non-First Nations academics, they acknowledge the First Nations knowledge holders, Mr. Larry Blight, Mr. Brendan Kennedy and Mr.

Trevor Kirby, who feature in the films being analysed. They also acknowledge the film makers, Inkey Media, Blackfella Films, and the Australian Broadcasting Corporation.

**Outcome:** This resource was considered valuable and appropriate for use and with further investigation of the First Nations knowledge holders, Nation, Country and/or Language can be added to the reference using the IKAT (First Nations knowledges as cited by non-First Nations authors), (see below).

Mengang Noongar, Kati Kati and Wadi Wadi in Langley, M. & Diamond, L. Firstever biomechanics study of Indigenous weapons shows what made them so deadly. The Conversation 2024.

Or, you may also choose to acknowledge each First Nations contributor. This is not suggested in the IKAT; however, it may be an option to consider.

Blight, L. (Menang Noongar), Kennedy, B (Tati Tai, Wadi Waddi), and Kirby, T (Wadi Wadi) in Langley, M. & Diamond, L. First-ever biomechanics study of Indigenous weapons shows what made them so deadly. The Conversation 2024.

### **Examples of Primary Sources**

As scientists, when researching First Nations knowledge, a fundamental shift in the way we think about sources of information is required. We need to look well beyond peer-reviewed journals to find primary sources of information. In fact, until recently, journal articles rarely presented work that had been generated by working in respectful consultation with First Nations peoples. Traditional publications are still struggling to adequately include co-designed research or research for Community and attribute contributions adequately. Therefore, when accessing journal articles, it is particularly important to evaluate the appropriateness and respectfulness of the resource before sharing with students and if quoting from a source ensure the language is amended to ensure it is respectful by today's standards.

A first-hand account of knowledge from a First Nations person is a primary source. In the past, First Nations knowledges shared by a First Nations person

were often ignored or devalued. Today we recognise, respect, and celebrate the wisdom of First Nations knowledge holders. A primary source from a First Nations person could be authored texts, video interviews or even YouTube content.

Always be mindful to avoid asking about or seeking out secret and sacred Knowledge (see page 29). The best way to do this is to avoid content that is related to 'closed ceremony'. Instead, focus on aspects of culture that relate to 'the day-to-day practices associated with home'. For example, the technology associated with the blade of a knife, or cooking practices, and farming. If you are not sure if content is secret and sacred, it is best to seek advice. Most universities have strategies and teams to support the inclusion of First Nations knowledge, and they may be able to advise.

When considering primary sources, you need to evaluate them using the principles from IKAT. For example, when evaluating a YouTube clip consider:

• Who created the video resource? Was it created by First Nations Australians or a non-First Nations person capturing the information. Did they have permission to record this information?

• Who released the video to the web? Was it released by a First Nations person or a non-First Nations person? Who benefits/profits from the release of the video?

• Was the video sharing information approved by the Traditional Owners of that information?

• Can you find all the information you need to ensure correct attribution to the person who has shared knowledge?

### PunukuTjukurpa Education Kit

https://maruku.com.au/wp-content/uploads/sites/19/PunukuTjukurpa\_ EducationKit.pdf

This PDF was available via Maruku - owned and operated by Anangu Peoples of Central Australia. It features *punu* (carved wooden objects) and *walka* boards (patterns created using hot wire, carving and painting that has cultural and ritual significance) created by three generations of Anangu (peoples from an area in the Western Desert cultural bloc region) from the Anangu Pitjantjatjara Yankunytjatjara (APY) Lands, Ngaatjatjarra Lands and Ngaanyatjarra Lands.

These materials were developed by Artback NT for use in schools and at exhibition venues, based on the work of Anangu. The activities may be reproduced for teaching purposes.

**Outcome:** The kit was considered valuable as a resource for teaching purposes. As the resource was created in collaboration with First Nations knowledge holders, correct attribution can be made. While the resource lists all the cultural advisors, Billy Cooley, Rene Kulitja, Janet Inyika, Judy Trigger, Lydia Angus, Niningka Lewis, Kathy Tozer and Clive Scollay, referencing might be problematic using the IKAT. Here it is suggested to state the First Nations languages as cited in the document. However, it may also be acceptable to state the cultural advisor and place Anangu after the name. For example; Cooley, Billy (Anangu). If his language group was known, then you may also attribute this after Anangu, (see below).

Anangu Ngaanyatjarra, Pitjantjatjara, Yankunytjatjara and Ngaatjatjarra in Art Back NT, Maruku Arts, the representative body for Punuku Tjukurpa, PunukuTjukurpa Education Kit (n.d.) <u>https://maruku.com.au/wp-content/uploads/</u> <u>sites/19/PunukuTjukurpa\_EducationKit.pdf</u>

### **First Weapons ABC**

First Weapons, ABC Education, 2023, part 2 Amerr <u>https://www.abc.net.au/</u> <u>education/digibooks/first-weapons/102398250?vcOpensOnLoad=true&vcPage</u> <u>Id=103043328</u> Accessed 2024.

This video explores the design, manufacture, application and science of the *Amerr*, a spear thrower produced by the Traditional Owners of Alyawarr Country in the Northern Territory. While the video is published by ABC Education, the information is a primary source, and full attribution is given to the First Nations knowledge holders, John Duggie, Frank Holmes, Donald Thompson and Casey Holmes.

**Outcome:** The video was considered a valuable resource for teaching, as an example of a respectful primary source. Furthermore, First Nations knowledges Amerr Alyawarr can be cited in the referencing, (see below).

Alyawarr Amerr in in ABC Education, First Weapons, part 2 Amerr. (2023) <u>https://</u> <u>www.abc.net.au/education/digibooks/first-weapons/102398250?vcOpensOnLoad=</u> true&vcPageId=103043328 Accessed 2024.

Or, you may also choose to acknowledge each First Nations contributor. This is not suggested in the IKAT; however, it may be an option to consider.

Duggie, J (Alyawarr Amerr), Holmes, F (Alyawarr Amerr), Thompson, D (Alyawarr Amerr) and Holmes, C (Alyawarr Amerr) in ABC Education, First Weapons, part 2 Amerr. (2023) <u>https://www.abc.net.au/education/digibooks/first-weapons/102398</u> 250?vcOpensOnLoad=true&vcPageId=103043328 Accessed 2024.



First Nations Australians have long used basalt and other durable stones to manufacture axe heads. These stone axes held their sharp edge after skilled shaping and polishing. Axe heads were traditionally hafted to wooden handles for improved mechanical efficiency. Image captured by J. Sambono

### Appendix D Example Framework template

Curriculum development that	First Nations world science context	Introduction to the topic. First Nations Peoples from <b>around the world</b> have long used <u>Physics</u> (discipline), e.g. <u>A</u> diverse range of levers designed for specific purposes <u>e.g. hunting and fishing. Atlatl (spear-thrower) Mayans /Aztecs &amp; the becket (sling) North</u> <u>African First Nations Peoples.</u> <u>https://www.britannica.com/technology/spear-thrower</u> (topic)
can be undertaken independently • Identify (through desktop research) culturally appropriate	Australian context	Use of <u>Physics (discipline</u> ) has long been used by <b>First Nations Australians</b> . e.g. <u>Spear throwers</u> , often referred to as a 'woomera', have been long used by First Nations <u>Australians'</u> across this continent, to increase the velocity of hand thrown spears. Formal variation in Australian spear and spear-thrower technology, B.J. Cundy, 1980 (topic)
context for inclusion in the curriculum. • Ensure critical analysis of sources and include First Nations knowledge attribution.	Regional context	Summary of the broad usage of <u>Physics</u> (discipline) by <u>(discipline) by</u> <u>(discipline) by</u> <u>(multiple First Nations Communities</u> throughout Australio) <u>For example, the spear throwers</u> of the Kuuku <sup>(1</sup> ) <sup>4</sup> v People are narrow, Alat and Iong. Links to the past: Woomera from central Cape <u>York Peninsula</u> , Flinders University, College of Humanities, Arts and Social Sciences, Dearden, <u>M.</u> (topic) 2021
<ul> <li>Showcasing non-secret/sacred known fact (freely available information e.g.: published w about First Nations Australians' science.</li> </ul>	ts orks) Local/Specific context	A factual showcase of the cultural science context in the public domain <b>attributed</b> to <u>the</u> Pitjartjatjara Rooples of northern South Australia (name) Community/People as it relates to <u>Physics</u> (discipline). e.g. For example, the application of levers in the design of spear throwers (Miru) to maximize the velocity of spears. <u>Punuku Tjukurpa EducationKit pdf</u> (topic)
Curriculum development that MUST be undertaken with Community	Specific Peoples ICIP	When planning to use/replicate/investigate, <u>spear throwers, Miru</u> (cultural science context) seek authorization from the <u>Ptijantjatjara Community</u> (name) Agency/ Corporation/Group/Community/ Knowledge Holder to permit and/or share detailed ICIP in the agreed manner. <u>https://anany.com.av/about-us</u> Anangu Ptijantjatjara Yankunytjatjara (APY) was incorporated by the 1981. Anangu. Ptijantjatjara (Aphy Met.
<ul> <li>Deep knowledge (ICIP) owned by respective First Nations Peoples, used in teaching and learning by using specific science.</li> </ul>	Investigate the cultural science practice	Collaboratively <b>discuss the connection</b> between the <u>Physics</u> (discipline) that underpins respective cultural scientific practice of <u>spear throwers - Miru</u> (cultural science context).
Seek Community support through building reciprocal relationships with respective First Nations	Collaboratively align cultural science with discipline concepts	Identification and interpretation of the specific cultural science <i>(knowledge, technology or process)</i> <u>Spear thrower – Minu</u> relevant to the accredited science curriculum content/concept and learning outcomes.
Australians' Community.	Using cultural science ICIP for teaching and learning	In agreement with the respective Community <u>Pitjahtjatjara Community</u> (name) collaboratively and/or independently use a cultural science context <u>Spear throwers - Miru</u> to develop a learning experience, <u>incursion</u> (activity), to drive the learning of the relevant tertiary science concept.

### Appendix E Framework template

		Introduction to the topic. First Nations Peoples from <b>around the world</b> have long used
Curriculum development that	First Nations world science context	(topic)
can be undertaken independently · Identify (through desktop research) culturally appropria	ate Australian context	Use of( <i>discipline</i> ) has long been used by <b>First Nations Australians</b> . e.g
context for inclusion in the curriculum. • Ensure critical analysis of so and include First Nations knc attribution.	ources owledge	Summary of the broad usage of
<ul> <li>Showcasing non-secret/sac (freely available information e. about First Nations Australial</li> </ul>	cred known facts Local/Specific as: published works) context ans' science.	A factual showcase of the cultural science context in the public domain <b>attributed</b> to
Curriculum developm that MUST be underta with Community	aent aken Peoples ICIP	When planning to use/replicate/investigate,
<ul> <li>Deep knowledge (ICIP) own respective First Nations Peop used in teaching and learning using specific science.</li> </ul>	ed by ples. g by science practice	Collaboratively <b>discuss the connection</b> between the
<ul> <li>Seek Community support through building reciprocal relationships with respective First Nations</li> </ul>	Collaboratively align cultural science with discipline concepts	<b>Identification and interpretation</b> of the specific cultural science <i>(knowledge, technology or process)</i> relevant to the accredited science curriculum content/concept and learning outcomes.
Australians' Community.	Using cultural science ICIP for teaching and learning	In agreement with the respective Community(name)(name)(name) collaboratively and/or independently <b>use</b> a cultural science context( <i>activity</i> ), to drive <b>to develop a learning experience</b> ,( <i>activity</i> ), to drive the learning of the relevant tertiary science concept.

### ISBN: 978-0-7300-0196-6

A tidal estuary, Gununa, Mornington Island, Gulf of Carpentaria QLD. Image captured by J. Sambono