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Exploring the Medicinal Properties of Indigenous Plants Within an Enabling Program: Bridging the Gap Between School, Aboriginal and Torres Strait Islander Knowledge and Science.

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Abstract

In 2021, less than half of Australian universities considered Indigenous perspectives in curriculum development, with only 15% ensuring Indigenous content in all courses. Literature acknowledges that a strengths-based approach to the inclusion of Aboriginal and Torres Strait Islander knowledge and perspectives, enhances representation and decolonises curriculum. In 2020, Noongar elder Vivienne Hansen, and John Horsfall created *Noongar Bush Medicine*, detailing the medicinal use of Indigenous plants. Yeshi, Turpin, Jamtsho, and Wangchuk noted that many Aboriginal and Torres Strait Islander communities use native plants for health purposes. However, there is limited data on the therapeutic efficacy of these plants. In 2024, the Science Unit Coordinator in Edith Cowan University's UniPrep enabling program (located on Whadjuk Noongar boodja and Wadandi boodja) designed a module examining the medicinal properties of Indigenous plants, engaging students with Aboriginal and Torres Strait Islander knowledge as a core component of science. The experiment involved testing the medicinal use of: moorngan/tea tree (*Melaleuca radula*), eucalyptus (combination of species), uilarac/waang/wolgol/wollgat/sandalwood (*Santalum spicatum*), and honey using nutrient agar microplates inoculated with *Escherichia coli* and *Staphylococcus epidermidis*. This paper adopts a practical/operational action research methodology to discuss the: context/problem, action, observation and reflection on the curriculum initiative. Preliminary findings suggest that this module enhances student engagement and fosters appreciation for Aboriginal and Torres Strait Islander knowledge systems and STEM. This inclusive, hands-on learning module also addresses barriers faced by students from non-traditional backgrounds in accessing STEM, highlights the underrepresentation of Indigenous knowledge and science-focused curriculum in Enabling Education research.

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Introduction

There has been a focus in recent years to include greater Aboriginal and Torres Strait Islander perspectives in tertiary curriculum and pedagogy. However, universities have an ongoing role in recognising the continued impacts of colonisation on Aboriginal and Torres Strait people and ensuring Aboriginal and Torres Strait Islander students can see their peoples, values, perspectives and knowledges present across the curriculum, disciplines, and structures of academia (Universities Australia, 2022, p.10). *A Guide for Curriculum Development First Nation Australian's Science* (Ah Chee et al., 2024), which utilises the seminal work of Professor Joe Sambono (Jingili), proposes "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" (p. 8). While "Aboriginal and Torres Strait Islander" is used in this article, terms "First Nations" and "Indigenous" are also used when referring to specific research and literature that uses these terms. Integrating Aboriginal and Torres Strait Islander knowledge, fosters awareness and appreciation of the wealth of Aboriginal and Torres Strait Islander scientific knowledges. As Ah Chee et al. (2024) note elevating such perspectives in the tertiary curriculum "ensures that, at a minimum, universities are producing a pipeline of future scientists with fundamental awareness and respect for Aboriginal and Torres Strait Islander science" (p.10). Moreover, the current underrepresentation of Aboriginal and Torres Strait students in higher education, highlights the need for students to "see themselves in the curriculum" as a crucial step towards inclusivity and equitable education. Increasing Aboriginal and Torres Strait Islander perspectives enhances the learning experience for these students and holds the potential to foster an increase in their transition towards undergraduate degrees in science, which is a national priority area as recognised in the Universities Australia Indigenous Strategy (2022) and The Australian Universities Accord (Department of Education, 2024).

An intersection between tertiary science, technology, engineering and mathematics (STEM) participation and Enabling Education is recognised in the Accord, as enabling programs are noted as fundamental to achieving new attainments for participation (Department of Education, 2024). Including Aboriginal and Torres Strait Islander perspectives through STEM-focused activities in enabling curriculum, not only "illuminates relevant scientific contexts for all learners" (Ah Chee et al., 2024, p.8), but creates a strong foundation for studies in science-related fields. In 2024, the Science Unit Coordinator in Edith Cowan University's (ECU) UniPrep enabling program recognised the absence of Indigenous perspectives in the curriculum. The research questions informing the curriculum redesign that resulted and this paper were framed using a constructivist lens. These questions are: (1) How can enabling science curriculum build a bridge between two scientific systems, to enhance student engagement and provide an inclusive pathway to STEM education? (2) How can curriculum: empower students to connect with science through practical skill-building and to develop an appreciation of diverse knowledge systems, while also making science more accessible and meaningful, as well as supporting students' academic and professional aspirations?

This project draws on practical/operational action research design: problem, action, observation and reflection to address the two research questions. Action research is recognised as a useful methodology for reflecting and evaluating teaching and learning initiatives, particularly those focused on social justice education (Barber et al., 2020; Gibbs et al., 2016; Zerquera et al., 2017). This paper documents the context, module design, experiments and early findings of a redesigned science module that examined the medicinal properties of Indigenous plants, engaging students with Aboriginal and Torres Strait Islander scientific knowledge as a core component of science. The presence of an Indigenous garden in the Health Science precinct on Whadjuck Noongar boodja Edith Cowan University, which represented the Noongar seasons' plants, was an inspiration for exploring the potential medicinal benefits of plants. Oils from moorngan/tea tree (*Melaleuca radula)*, eucalyptus (combination of species), and uilarac/waang/wolgol/wollgat/ sandalwood *(Santalum spicatum),* (Hansen & Horsfall, 2020) and honey were applied to circular paper discs and impregnated on inoculated nutrient agar plates to record sensitivity. Nutrient agar microplates were inoculated with human bacterial species *Escherichia coli* and *Staphylococcus epidermidis.* The goal of the modules conceptual focus was to strengthen the understanding of Aboriginal and Torres Strait Islander medicinal use of plants, by combining hands-on learning and two epistemologies of science, highlighting intersections.

The journey to honing “cross-cultural intelligence” and developing science curriculum that includes Aboriginal and Torres Strait Islander perspectives, knowledge and histories, starts with educators understanding positionality, and Indigenous Cultural and Intellectual Property (Ah Chee et al., 2024, p. 24). For thoughtful and respectful curriculum design, it is important that First Nation positionality, as well as that of the non-Indigenous designers/co-authors is clarified. The non-Indigenous Unit Coordinator identified her position as outside of community, and not holding cultural knowledge. Both the Unit Coordinator and academic (medical scientist), with histories in Eurocentric science in chemistry and microbiology, recognised their role as “showcasing” Aboriginal and Torres Strait Islander scientific knowledge (non-secret/sacred facts), rather than teaching culture (Ah Chee et al., 2024, pp 26-27). Thus, no cultural practices relating to medicinal plant preparation or oils took place. As per the Educator Framework the educator goals for these inclusions were to ensure that “First Nations Australians can see themselves in science curriculum” and expose learners to scientific knowledge systems to “develop cross-cultural capability required of 21st century scientists” (Ah Chee et al., 2024, pp 26-27).

Literature

Enabling and Science Context

Enabling/preparation pathways provide access to university for underrepresented cohorts. While these programs differ in design, length, and delivery, *The typology of enabling programs in Australia 2023,* highlights that they share similarities in teaching core literacy and maths units that focus academic skills critical for student transition into university, as well as discipline specific – Science and Humanities – electives. Sector literature highlights that Australian enabling students are often from government defined equity groups, are underrepresented within tertiary settings, have educational disadvantage or disruption, and face compounding challenges in their lives and learning (Gale & Parker, 2013; Gale & Tranter, 2011; Jones et al., 2016). Addressing the academic needs of cohorts with “vast differences in educational backgrounds, aspirations, interests and motivations” (Jones et al. 2016, p. 23) is a complex task (Hodges, Bedford, Hartley, Klinger, Murray, O’Rourke, & Schofield, 2013; Lisciandro & Gibbs, 2014). In recent history science and maths literacy levels in Australia have been a point of concern. In 2015 the *Program of International Student Assessment* highlighted that “for each of the school sectors [government, independent and Catholic] the average scientific literacy performance declined significantly between 2009 and 2015” (Thomson et al., 2016). Whilst the *National Assessment Program (NAP) report* shows that literacy levels have steadied since 2018 (ACARA, 2024), there are still large gaps between Indigenous and non-Indigenous students. In 2023 34%, or one in three, Indigenous students in year 6 (compared with 58% non-Indigenous), and 28%, or one in four, year 10s (compared with 55% non-Indigenous) achieved proficiency standard in test, which has improved for year 10s 2018 results of 20%. In a 2015 Australian study on the maths and science literacy of year 4s and 8s, students at metropolitan schools performed greater than those attending a provincial/regional school, and students attending a regional school performed higher than those at remote schools (2015b). The 2024 NAP report shows that there is still a substantial gap in science literacy between metropolitan schools and regional and remote. Stating that “in 2023, almost 60% of Year 6 and Year 10 students in major cities achieved the proficient standard. In regional areas, the percentage was still above 50% in Year 6 but dropped to 42% in regional areas in Year 10 and in remote areas for Year 6” (NAP 2024, p.22). Additionally, Thomson et al.’s research highlighted a substantial gap in literacy between students attending affluent and non-affluent schools (2016). The availability of educational resources was also noted as a factor, and data showed that for year 8s, “46 per cent attended schools where science instruction was *affected*; and one per cent attended schools where science instruction was *affected a lot* by resource shortages (Thomson et al., 2016, p. 157). Schools in these contexts frequently lack the necessary facilities, equipment, trained teachers, or opportunities to offer ATAR-level science subjects. Poor educational resources, due to school location or economic level, limits access to hands-on science learning experiences, which are essential for developing tangible skills and a deeper understanding of scientific principles.

Enabling students, as acknowledged are often from low socio-economic backgrounds, rural and regional areas, or have face significant educational disadvantages. A study of enabling students from Murdoch University’s *OnTrack* program focussed on the impacts of past experiences on perceptions towards maths and science, highlighted that prior to their enrolment fifty percent of the respondents had “studied science or maths in the two years” a third of students had not studied either subject for the past 2-10 years, a tenth for more than a decade, and fewer than one percent articulated that they had never studied either subject (Lisciandro et al., 2018, p. 21). Thirty percent of this cohort were low socioeconomic status (SES), and thirty six percent were studying on a regional campus. Lisciandro et al. note that “the most significant finding in this analysis is the impact of teacher quality on student experiences and their perceptions of science” (2018, p.23). Additionally, they found that for those students who had a negative or neutral experiences in their past education that ‘interest’, ‘enjoyment’ and ‘conceptual understanding’ were linked (Lisciandro et al., 2018, p.23). When reviewing the outcomes of a regional enabling programs Andrewartha and Harvey noted that students received lower marks in the science units compared with maths and social sciences (2014, p. 63). Thus, within enabling programs there is a pressing need to develop and deliver engaging curriculum, theory and practical laboratory sessions tailored for students who aspire to pursue STEM subjects at university but are non-ATAR or from nonmainstream educational pathways (Buxton & Lee, 2007). Unlike textbook or device-driven approaches, hands-on experiments and working with physical materials, and developing fine motor skills allow students to actively engage with the process of discovery and experimentation. This practical approach not only builds technical proficiency but also fosters curiosity and confidence in science.

Australian universities are increasingly embedding Indigenous knowledges into teaching and learning, guided by national strategies (Department of Education, 2024; Universities Australia, 2022) and institutional frameworks’ Indigenous Education Statements, and Reconciliation Action Plan. While progress is evident through initiatives like Charles Darwin University’s student partnerships, Queensland University of Technology, Edith Cowan University and Royal Melbourne Institute of Technology’s professional development programs, and Curtin and Australian Catholic University's focus on cultural competency, only one-third of institutions have formal protocols in place, highlighting a gap between policy and practice (Dianati, 2024). Enabling programs play an important role for Aboriginal and Torres Strait Islander student transition to university (Universities Australia, 2022, p.10; Uink, Bennett, Hill, van den Berg, & Rolfe, 2022, p.43). Thus offer a key opportunity to embed Indigenous perspectives, as well as address access to, and gaps in, STEM knowledge, and foster culturally safe learning environments.

Indigenous Plants

Plants often contain active components that serve as valuable chemical leads for the development of novel therapeutics, a process heavily utilized by pharmaceutical companies over the last 100 years (Suleria, Goyal, & Saqid Butt, 2019). As noted by Barkandji researcher Zena Cumpston much medicine in plastic bottles was derived from plants or are synthetic adaptations (2022). In many developing countries, such as those in Ghana and Latin America, medicinal plants remain the primary source of health care for large populations (Asante et al., 2025; Calixto et al., 2005). Similarly, Wangchuck (2020) highlights numerous examples of medicinal plants used by Himalayan communities. Australian Aboriginal and Torres Strait Islander communities have used plants for food and medicine since time immemorial (Hansen & Horsfall, 2020). Each region of Australia is home to a diverse array of plant species native to its environment, with each state and territory boasting plants with distinct medicinal properties. Cumpston et al. (2022) write, "plants provide a powerful opportunity for learning and connection, opening pathways to reinforce our knowledge, custodianship and continued presence, and to illuminate the all-important specificity of place foundational to our diverse Indigenous cultures" (p. 17). Due to the geographical spread across the country/Countries, Aboriginal and Torres Strait Islander communities developed different ethnopharmacology, as plants had varying "botanical profiles" and different uses (Savigni, 2016, p.179). A recent study identified tropical plants with anti-inflammatory properties, mapping their modes of action and therapeutic potential in far northern Western Australia, the Northern Territory, and Queensland (Yeshi et al., 2022). Aboriginal and Torres Strait Islander communities continue to use Indigenous plants for preventative and curative purposes, even with access to modern health care systems (Cumpston et al., 2022; Yeshi et al., 2022; Hansen & Horsfall, 2020). However, for many of these plants, there is limited therapeutic data available on their modes of action or efficacy, particularly regarding oils and extracts. This underscores the need for further research to explore and validate the medicinal potential of these resources.

Each Aboriginal and Torres Strait Islander Australian Country/region has its own language, culture, and nuances in language that can be recognised in differences in plant names. Such examples moorngan/melaleuca (tea tree), wandoo/jarrah/moich (and other species in Noongar and other languages) eucalyptus, and uilarac/waang/wolgol/wollgat/sandalwood. All species are known for their essential oils, which contain a range of bioactive compounds with medicinal properties. The oils are rich in terpenoids, alcohols, and other volatile constituents that contribute to their antibacterial, antifungal, and anti-inflammatory effects. The key active compounds in each plant play a significant role in their Aboriginal and Western therapeutic applications. Recently there have been reviews on their activities, and Kairey et al. (2023) conducted a systematic review on the efficacy and safety of *Melaleuca alternifolia* (tea tree) oil for human health. Oil from Melaleucas contains terpenoids in various amounts. The compound terpinene-4-ol (4-Methyl-1-(propan-2-yl) cyclohex-3-en-1-ol) is the most abundant and is thought to be responsible for most of the melaleuca oil's antibacterial or antiseptic activity (Lassak & McCarthy, 2001). Tea tree (Melaleuca) is used in Aboriginal medicine for various ailments. As Hansen and Horsfall note that leaves were crushed and inhaled for their vapours to relieve headaches and colds, or infusions were consumed to ease congestion, colds, and headaches, or applied externally to treat skin conditions and wounds. Additionally, the bark was soaked and used on wounds for its anti-inflammatory properties (Hansen & Horsfall, 2020). Carson et al., (2006) reviewed the antimicrobial, anti-inflammatory and medicinal properties of *Melaleuca alternifolia* (tea tree) oil for understanding its mechanisms of action, clinical efficacy, as well as the potential toxicity of the oil if ingested. The knowledge of plant preparation to avoid toxicity is reflected within the Aboriginal and Torres Strait Islander scientific system (Cumpston, 2022). Savigni and Pearn additionally note that "relatively few medicinal plants were taken internally as Aboriginal people have always retained an extensive and detailed knowledge of botanical toxicology" (2016, p.179; Pearn, 2005, p.287).

Oil obtained from the leaves of all eucalypt species contains 1,8-cineole (1,3,3-trimethyl-2-oxabicyclo [2.2.2] octane), also referred to as eucalyptol has antibacterial, antioxidant, anti-microbial and respiratory anti-inflammatory properties (Hoch et al., 2023). The oil also contains alpha-pinene, limonene, and terpineol which all have antibacterial, anti-inflammatory, anti-viral and anti-fungal properties (Surbhi et al., 2021). Chandorkar et al. (2021) and Savigni (2016) discussed the pharmacological actions of e*ucalyptus* and how it has been historically used, for treating a variety of conditions, including respiratory and digestive issues, fever, and pain in Aboriginal and Torres Strait Islander medicines). Like tea tree, all parts of the eucalyptus tree are used. The bark can be soaked in water to treat sores and wounds or boiled and inhaled to alleviate cold symptoms (Lassak & McCarthy, 2001). Hansen and Horsfall (2020) note that in Southwestern Australia, the leaves of all eucalyptus species are crushed and used for different purposes, such as antibacterial poultices for healing wounds, as well as in steam pits or held under the nose to relieve congestion from colds and flu. Additionally, the gum is ground and applied as an ointment for sores, and it was also consumed to relieve dysentery (City of Joondalup 2011; Cunningham, 1998).

Similarly, sandalwood essential oil is valued for its distinctive fragrance and potent medicinal properties, including antitumor, anti-inflammatory, and antimicrobial effects (Head & Cumpston, 2022). Yan et al. (2024) examined the biological properties of sandalwood oil and the microbial synthesis of its major sesquiterpenoids. Its key bioactive compounds, (Z)-α-santalol ((*Z*)-5-(2,3-Dimethyltricyclol [2.2.1.0^{2,6}] hept-3-yl)-2-methylpent-2-en-1-ol) and (Z)-β-santalol, play a crucial role in both its therapeutic activities and characteristic woody aroma. In Aboriginal medicine various parts of the sandalwood tree are used for healing purposes, such as the decoctions made from the inner bark are consumed as cough remedies to alleviate bronchitis. Additionally, oil extracted from the nuts can be applied to the skin to ease colds and muscle stiffness (Lassak & McCarthy, 2001). Like tea tree and eucalyptus, crushed leaves are used to create poultices for treating burns, scalds, and sores (Cunningham, 1998).

The authors acknowledge that Indigenous plants occur naturally in local regions, and their local names can vary between Countries, as noted. While the experiments were conducted on Whadjuk and Wardandi Country, the medicinal plants and honey used were a combination of species, not just unique to Noongar boodjar, thus common terms for these plants will be used within this paper.

Method

Context and Problem

ECU's campuses are located on Whadjuk Noongar boodja and Wardandi boodja in Western Australia. UniPrep is Edith Cowan University's preparation course designed to equip students with the skills needed for academic success and support their transition into university. The program emphasises independent learning and includes three compulsory units—Academic Writing, Learning Skills, and Mathematics—along with one elective (Science, BlaK Futurism or Humanities). The Science unit is tailored for students interested in science-related degrees, including medical and health sciences, nursing, and paramedicine, as well as those with a general interest in science. The unit runs twice a year, accommodating 300-400 students per semester. It is a hands-on course delivered in ECU's state-of-the-art SuperLab, a large teaching laboratory that can accommodate up to 96 students per session. This thirteen-week course introduces foundational scientific principles and methodologies, fostering critical thinking through modules on environmental sciences, microscopy, physics, and chemistry. However, a key gap in the curriculum was identified—the absence of Aboriginal and Torres Strait Islander science systems.

Action

A new module was developed to showcase Aboriginal and Torres Strait Islander scientific understandings of medicinal plants in treating bacterial and fungal infections in wounds. The goal was to privilege Indigenous scientific knowledge and highlight the "common ground" between Eurocentric Science and Aboriginal and Torres Strait Islander sciences (Ah Chee et al., 2024, p. 15). The development and implementation of the module and experiment would provide students with an opportunity to engage with Indigenous scientific knowledge as a central and foundational component of understanding science. The experiment was designed to examine the potential anti-bacterial, anti-microbial, and anti-viral properties of native plants of Western Australia and reveal the potential medicinal properties of indigenous plants. The choice to focus on the medicinal qualities of Indigenous plants was made as many of these plants exist on the Countries where the students are living and learning, so it offered an opportunity to develop real world knowledge that the students could apply in everyday life. Additionally, this area of science allowed for an explicit connection to be made between "ideas and processes common to both First Nations and Eurocentric scientific knowledges" (Ah Chee et al., 2024, p. 16).

Design

This module took place over two weeks of a twelve-week semester. The inclusion of Aboriginal and Torres Strait Islander plant based medicinal knowledge was showcased in one lecture, including references to text *Noongar Bush Medicine* by Noongar elder Vivienne Hansen, and John Horsfall. Lecture content focused on the significant impact of colonisation on Aboriginal health, particularly the introduction of diseases such as measles, mumps, diphtheria, whooping cough, and sexually transmitted infections. Lectures also highlighted the importance of the Noongar seasonal calendar in guiding the sustainable use of medicinal plants, including tea tree eucalyptus, sandalwood, and lemon-scented myrtle, in maintaining health and treating ailments. Aboriginal use of other Western Australian plants, such as old man saltbush (p*urngep*), coastal pig face (*bain*), beach spinifex, graceful honey myrtle (*moorngan*), lemon grass (*djirip*), balga/grass tree, running postman (*wollung*), red eye wattle (*wilyawah*), acorn banksia (*manyret*), and guinea flower (*ballyion*), their use and medicinal and nutritional properties, are showcased to reflect a deep ecological knowledge that sustained Aboriginal wellbeing for thousands of years. Finally, intersections and common ground with Eurocentric understandings of microbiology were highlighted to scaffold students into lab experiments where they would be utilising these methods. Three lab-based activities then took place over two weeks.

For a safe educational experience, these activities were led by tutors with backgrounds in science, who instructed the UniPrep students in laboratory techniques within the lab environment. Groups of 48 to 96 students participated in each session, supported by a team of tutors. Each tutor was assigned to a group of 16 students, providing guidance throughout the micro plating process and the subsequent analysis of results. The tutors demonstrated the experiment using nutrient agar plates inoculated with gram-positive bacteria *Staphylococci* or gram-negative *Escherichia coli (E Coli).* These plates were treated with discs saturated with native oils extracted from tea tree, eucalyptus, sandalwood and two Western Australian honeys. UniPrep students had a hands-on activity by collecting environmental swabs from designated areas on campus, personal items and skin to incubate bacterial growth. Students worked in pairs, requiring 48 nutrient plates per class of 96 students. This results in the incubation of approximately 150 environmental plates each week. To manage costs and time constraints, prepared plates were produced by technical staff, with one set allocated per group of four students across three activities.

Materials

Nutrient agar plates (PathWest prepared), Sterile swabs (Sarstedt), Sterile glass “hockey sticks”, Swab/Loop holder block, Eppendorf tubes 1.5 mL graduated microtubes (to hold sterile water for swabs) (SSIbio), Permanent markers (Sharpie), tea tree oil (*Melaleuca radula)* (Plantation), eucalyptus oil (*Eucalyptus todtiana)* (Bosisto by Felton and Grimwade), sandalwood oil (*Santalum spicatum) (*Australian Botanical Products), Honeys: Manuka MGO400 (Honey for Life) and Jarrah TA40 (Elixir), *Escherichia coli*, *Staphylococcus epidermidis* (Southern Biological), incubator, Autoclave, Autoclave bags (Sarstedt), Bunsen burner, Sticky tape (Officeworks), Bench protector (Kimberly-Clark), Spray bottle of 70% Ethanol, Cork Borer, Lab based hole punch, Chromatography paper.

Preparation

Nutrient agar plates were inoculated with *Staphylococcus epidermidis* (Gram-positive cocci) and *Escherichia coli* (Gram-negative bacilli) in a lawn growth application. Agar plates were prepared using aseptic technique. All media was sterilised prior to use. Once sterile, media and agar plates were not opened until immediately before use and not left open. No caps or lids left on the bench. The bottle neck was flamed immediately after cap removed and before cap was replaced. Using a suitable sized laboratory micropipette with a sterile tip, 100mL of nutrient broth containing bacteria, (E. coli) was placed onto a fresh clean nutrient agar plate.

A sterilised, glass ‘hockey stick’ was then used to spread the bacterial solution e.g., Escherichia coli (E. coli) to form a ‘bacterial lawn’ (confluent growth). All hockey sticks (or loops) were sterilised between use, using 100% Ethanol, and loops passed through a Bunsen burner flame. A sterile punch was used to create wells in the nutrient agar for the two honey samples. The antimicrobial agents, (i.e., chromatography paper circles soaked in the oils) and the honey samples (placed in the wells), were then added to the plates, and sealed with Parafilm. The plates were then incubated at 37°C for 24 hours.

Note: The plates are placed upside down, so that condensation does not collect on the surface of the agar. However, as the honey samples were applied to wells in the agar, this was not possible. The workspace was clear of clutter; the Bunsen burner and containers were placed at a convenient working distance wherever possible. The sterile loop should not touch the sides of the culture tube or bottle.

Risk Assessment Summary

This experiment involves cultivating *Staphylococcus epidermidis* (Gram-positive cocci) and *Escherichia coli* (Gram-negative bacilli) on nutrient agar plates and sampling environmental surfaces. Bacterial plates were prepared aseptically by trained technicians using sterilized equipment and autoclaved post-experiment for safe disposal. Control measures included lab coats, gloves, enclosed shoes, and instructions to avoid opening sealed plates. Environmental samples were collected only from external surfaces (excluding bodily fluids), incubated at 30–37°C for 24 hours, and stored at 4°C for analysis. The experiment was conducted in a well-ventilated lab to minimize exposure risk. These precautions and adherence to standard operating procedures ensured a safe and controlled environment for students' microbiological investigation.

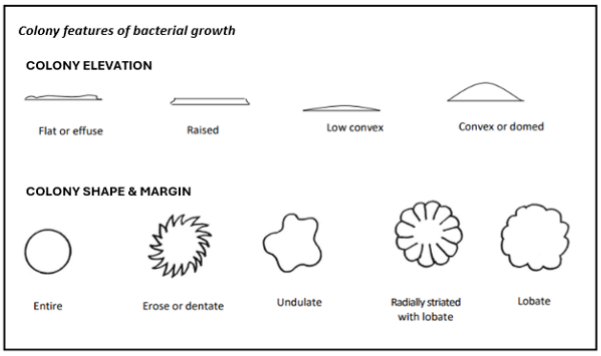
Activity 1: Examination of nutrient agar plates with Staphylococcus epidermidis and Escherichia coli.

The students examined the prepared sealed plates of *Staphylococcus epidermidis* and *Escherichia coli* provided, recorded the growth, and described the colonies present using the information provided Figure 1 (Bergey & Holt, 2000; Jones & Smith, 2019). Students drew the colonies visualised for the *Staphylococcal* and *Escherichia coli* species on nutrient agar plates and answered a series of questions to reflect on real life situations, such as name a site on the human body where these bacterial species could exist as part of the normal microbiota.

The human body hosts many bacterial species known as our normal microbiota. These exist synergistically, are usually non-pathogenic and can even be beneficial. However, if the body becomes rundown, or the bacteria colonise a different part of the body they can cause disease. For example, if bacteria enter the bloodstream, it can lead to serious illness.

Figure 1

Description and features of bacterial colony growth on nutrient agar medium.



Shape	Colonies
Size	Diameter in mm
Elevation	Flat, convex or umbonate
Surface	Smooth or rough, dull or glistening
Edge	Entire, undulated, crenated of rhizoid
Pigment	Colour and diffusibility
Opacity	Transparent, translucent or opaque
Odour	Absent, decided, definite or identifiable

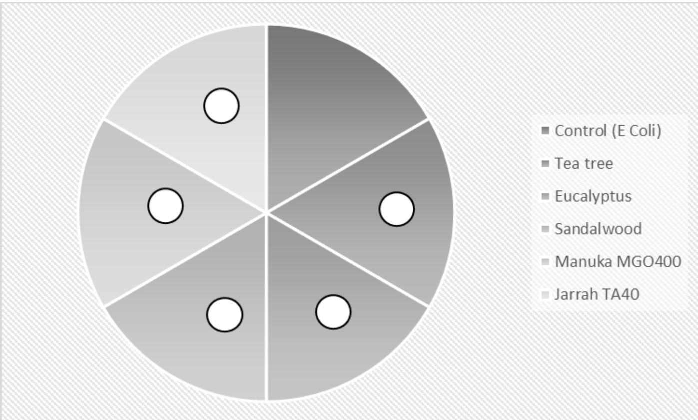
Bacterial colony morphology adapted from information provided by Bergey & Holt, 2000; Jones & Smith, 2019.

Activity 2: Examination of nutrient agar plates with Staphylococcus epidermidis and Escherichia coli with native oil inoculation.

For activity two, technicians prepared sealed agar plates using aseptic techniques, inoculating them with *Escherichia coli* and *Staphylococcus epidermidis*. Each plate was divided into six sections, with five sections treated with different antimicrobial agents: tea tree oil (*Melaleuca radula*), eucalyptus oil (*Eucalyptus sp.*), sandalwood oil (*Santalum spicatum*), Western Australian Manuka Honey (MGO400, Honey for Life), and Western Australian (WA) Jarrah Honey (TA40, Elixir). The sixth section has not been inoculated but left as *Escherichia coli* growth or *Staphylococcus epidermidis;* this served as a control. Each substance had been introduced on a small circular filter paper each with 20μL of sample. Samples 1-3, tea tree, eucalyptus and sandalwood, and sample 4-5 with two native WA honeys.

Figure 2

Diagram of Microplate Setup Showing Placement of Native Oil-Infused Paper Discs for Antimicrobial Testing.



Students were asked to draw and label the diagram carefully, including the colonies visualised for the *Escherichia coli* and *Staphylococcus epidermidis* species and the pattern with potential anti-microbial activity on the nutrient agar plates. A series of questions were asked, including which native plant oil tea tree, eucalyptus, sandalwood and or honey samples show the most anti-microbial activity, and asked to hypothesis why this would be. The concept of a control was introduced here to show no inoculation.

Activity 3. Plate streaking.

Nutrient agar plates were prepared by students working in pairs. "Environmental Plates" were labelled (Student/group ID, date, and time of lab) on the bottom with writing around the edge (underside of the plate, not the lid) so as not to obstruct the viewing platform. A vertical line was drawn using a black marker to show the divide between the two-environment swab surfaces and labels. Students used good aseptic technique and performed swabs from one environmental (e.g., taps, floor, computer screens) and one skin surface (e.g., behind ear, under fingernail). Nutrient agar plates were streaked for single colonies using the zigzag method.

To inoculate each section of the plate a new sterile swab was removed from the packaging, moistened with sterile water, and swabbed over an environmental surface, (iPhone, floor, under fingernail, hands (before and after washing), forearm, behind ear, hair (note no internal sites or body fluids are allowed).The swab is then gently streaked across the surface of a new agar plate in a horizontal zigzag fashion so as not to disrupt the agar gel. This method was repeated using a second site, ensuring the two do not overlap on the nutrient agar. Students were reminded not to remove the swab from the packet too early, and ensure the swab is kept horizonal so as not to gauge the agar. The lid was placed onto the agar plate and sealed with three strips of sticky tap. It was not completely sealed as this could promote anaerobic bacterial grow, so a gap was left for oxygen to get in. The plates were placed in an incubator at 37^0 C for 24 hours and then placed in a refrigerator at 4^0C after incubation to prevent overgrowth. Students then viewed their inoculated agar plates in the following week's laboratory session. By utilising pre-prepared plates for activities one and two, the experiment remained cost-effective while ensuring consistency and sterility. The student-led streaking activity in activity three allowed for hands-on engagement without large additional material costs.

Results

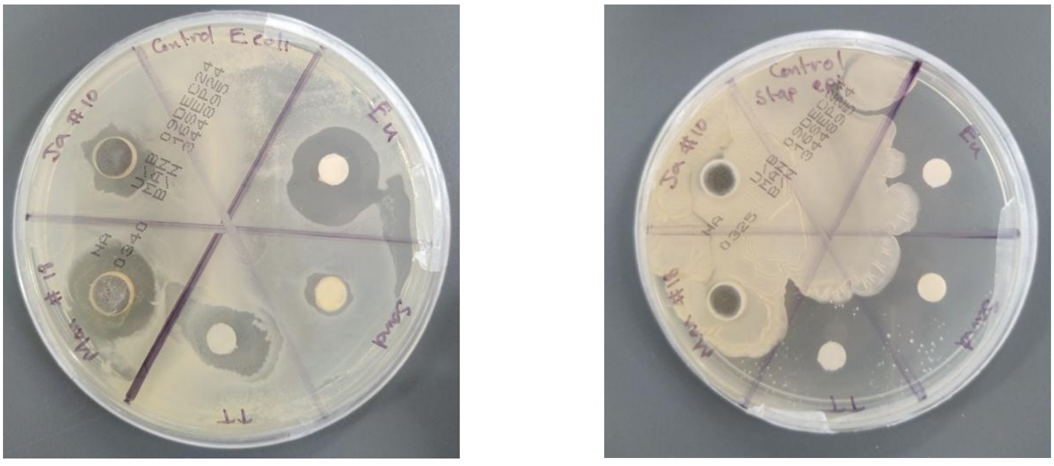
Activity 1 and 2: Observation of Plates

The laboratory experiences in this enabling program provided students with opportunities to develop scientific skills, critical thinking, and confidence in STEM. Students engaged with science through hands-on learning, authentic real-world applications, and an Indigenised curriculum, demonstrating both practical and culturally meaningful learning experiences.

In activity one through the observation and description of bacterial colonies on the plate and in activity two, they observed and described the inoculated incubated plates. Both activities developed skills in scientific observation and documentation. The students found that the antimicrobial agents exhibited varying degrees of bacterial inhibition. As shown in Figure 3 (plates were incubated at 37^0 C for 24 hour) the sixth section remained untreated as a control to observe uninhibited *Escherichia coli* growth as shown in (A) or uninhibited *Staphylococcus epidermidis* growth in (B).

Figure 3

Microplate Divided into Six Sections for Antimicrobial Testing with Escherichia coli (A) and Staphylococcus epidermidis (B)



(A) Microplate Divided into Six Sections for Antimicrobial Testing with Escherichia coli.

(B) Microplate Divided into Six Sections for Antimicrobial Testing with Staphylococcus epidermidis

The sections inoculated with tea tree oil (*Melaleuca radula*), eucalyptus oil (*Eucalyptus sp.*), sandalwood oil (*Santalum spicatum*), and the two honey samples, a clear zone of inhibition was observed, indicating suppression of *Escherichia coli* growth. In contrast, the untreated control section showed uninhibited bacterial growth, forming a confluent lawn. The size and clarity of the inhibition zones varied between treatments, suggesting differences in antimicrobial efficacy among the tested substances.

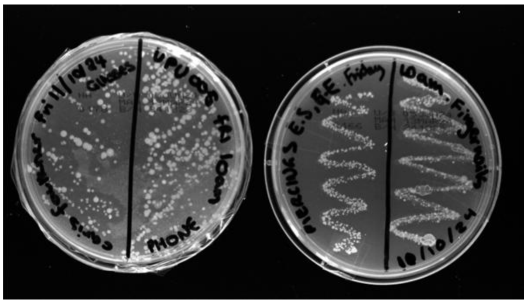
The antimicrobial agents demonstrated complete inhibition of *Staphylococcus epidermidis* growth. In the sections inoculated with tea tree oil (*Melaleuca radula*), eucalyptus oil (*Eucalyptus sp.*), sandalwood oil (*Santalum spicatum*), and the two honey samples, no bacterial growth was observed, indicating total suppression. In contrast, the untreated control section displayed uninhibited growth, forming a confluent lawn. The absence of bacterial colonies in the treated sections confirms the strong antimicrobial efficacy of these substances. In addition to varying microbial sensitivity noted in response to the inoculated oils and honeys used in this experiment, results were also consistent for antimicrobial susceptibility based on the bacterial cell wall structure. *Escherichia coli is* a gram-negative bacterium and thus, may only be partially inhibited by some antimicrobials due to the protective outer membrane. *Staphylococcus epidermidis* is a Gram-positive bacterium and has a thicker peptidoglycan layer in the cell wall. Interestingly, these bacterial colonies are more likely to be inhibited by antimicrobials as the protective outer membrane is not present.

Activity 3: Student's environmental plates

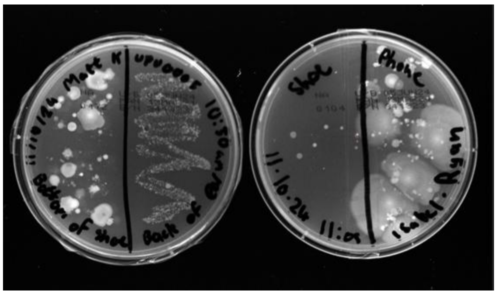
After incubation of students' "environmental plates", students observed microbial growth and compared colony formation across surfaces, noting differences in bacterial and fungal growth. Students learned that frequently touched areas, like door handles and phone screens, had more bacterial colonies than less-touched surfaces. This demonstrated the importance of hygiene and aseptic techniques in microbiology. Students also observed how agar provides nutrients for microbial growth and how environmental conditions (such as temperature) impact colony development. The experiment reinforced key microbiological principles, including contamination sources and the role of microbes in everyday life.

Figure 4

Student's Environmental Plates



(A) Phone, Glasses, Piercing and Under Fingernail



(B) Bottom of Shoe, Phone and Back of Ear.

Observation: Student findings

In class discussion, post activities asked students to reflect on their findings: what they observed on the plates, connection to understandings of Aboriginal and Torres Strait Islander scientific understandings of plants and medicine, and application of it to everyday life. Students identified that the modules content experiment was relevant to real-world applications, especially in healthcare, food safety, and public hygiene. Hospitals implement strict sanitation protocols to prevent bacterial spread, and this experiment highlighted why surfaces need regular disinfection. In food production, monitoring microbial contamination is crucial for preventing foodborne illnesses. In these discussions, the experiment developed students' awareness of the invisible microbes in our surroundings and the importance of washing hands frequently. Additionally, it is related to antibiotic resistance, as understanding microbial growth helps in developing better sanitation and treatment methods. Seeing how different surfaces – phones, shoes etc.- harbored varying levels of bacteria provided a real-world link between microbiology and health science.

Students were encouraged to reflect on this knowledge with their personal insights, and students expressed that this experiment changed how they viewed cleanliness, bacteria on common surfaces and how much growth appeared on objects that seemed clean. Students commented on how it questioned how often they cleaned personal items like their phones. They also realised the importance of careful lab techniques—small errors, like improper streaking, could affect results. Discussing their findings in class helped them develop their scientific communication skills using scientific terminology or technical language, especially in explaining microbial growth patterns.

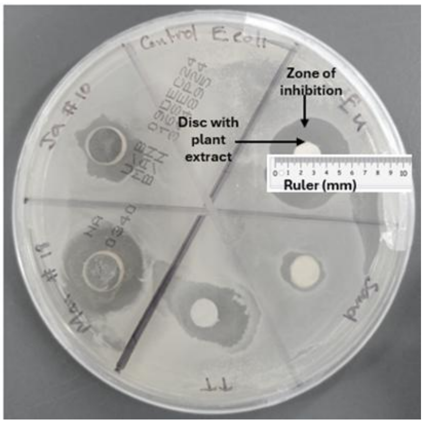
Tutors observed in these "findings" discussions, that students expressed that the experiment deepened their appreciation for microbiology and its real-world implications, reinforcing interest in how bacteria influence health, hygiene, and disease prevention. In Australia, students have access to affordable essential oils, which can be used for mild and minor ailments. This connects to the experiment's focus on hygiene and microbial awareness, as some plant-based oils have antibacterial properties that may complement regular cleaning practices. The Unit Coordinator's observations in the SuperLab were that students demonstrated strong engagement with the experiment, particularly in analysing the results rather than the technical aspects of plating. They showed the most interest in the environmental samples they swabbed, eager to observe bacterial growth patterns. Tutor feedback indicated that students were particularly impressed by the antimicrobial effects of the native oils and the inhibitory impact of honey on *Staphylococcus epidermidis* and *Escherichia coli*, highlighting their enthusiasm for the practical outcomes of the experiment.

Future considerations for the experiment

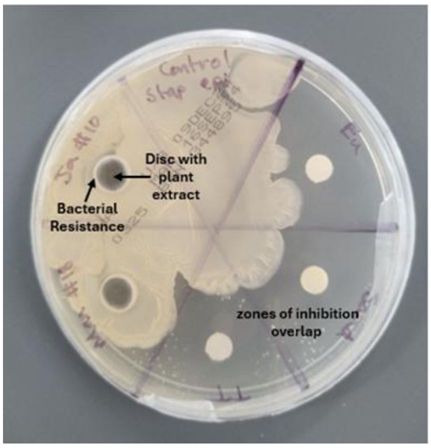
There are future considerations for experiment development in activities two and three. Activity two can be extended by asking students to perform a disc diffusion test. During incubation of the *Escherichia coli* and *Staphylococcus epidermidis* nutrient agar plates, the plant oil extracts, and honey will either spread and kill off an area of bacteria (resulting in visual 'zones of inhibition') or show no growth disturbance (resistance) (Giuliano et al., 2019). After incubation the students review the agar plates and document any bacterial sensitivity by measuring the clear area (antimicrobial halo) around the infused discs for each bacterial plate. Results for antimicrobial sensitivity can then be classified as 'Mild, Moderate or Strong' (based on the size of the zone of inhibition) or alternatively, 'Resistant' where there is no alteration in bacterial growth around the disc as shown in Figure 5 (Giuliano et al., 2019).

Figure 5

Antimicrobial disc diffusion testing for prepared nutrient agar plates.



(A) Antimicrobial disc diffusion testing using Escherichia coli plated on nutrient agar. Ruler (mm) measuring 'Zone of Inhibition' for Eucalyptus oil.



(B) Antimicrobial disc diffusion testing using Staphylococcus epidermidis plated on nutrient agar. Bacterial resistance noted for Manuka and Jarrah honey.

Finally, activity three can be expanded by incorporating a microscopy laboratory session where students are instructed how to prepare a smear using one of the multiple-coloured bacterial colonies from the environmental samples. Students can then visualise their own environmental prepared slides in a planned microscopy laboratory.

The scope of this experiment could be expanded by incorporating other natural plant-derived essential oils, such as lavender (Lavandula spp.), rosemary (Rosmarinus officinalis), and clove (Syzygium aromaticum), which have well-documented antibacterial properties. Lavender oil has demonstrated antibacterial, antifungal, and antimicrobial activity (Moon et al., 2006), while rosemary oil is known for its strong antioxidant and antimicrobial effects (Nieto et al., 2018). Clove oil, widely used in traditional medicine, has been shown to exhibit antibacterial activity against foodborne pathogens, including *Staphylococcus aureus* and *Escherichia coli* (Mostaqim et al., 2019). Future research could explore the efficacy of essential oils derived from native plants in different regions, such as those found in Europe, the UK, and other global locations, to determine their potential applications in antimicrobial treatments.

Discussion

Reflections on the initiative highlight that bridging the gap between Eurocentric and Aboriginal and Torres Strait Islander science systems, fosters a more holistic understanding of scientific inquiry, encouraging students to engage with science in meaningful and culturally responsive ways. These elements collectively enhance accessibility, foster engagement, and support students' academic and professional aspirations. The integration of hands-on laboratory experiences within Enabling Education played a critical role in shaping students' scientific identity and confidence. By engaging in authentic, real-world learning, students develop essential scientific skills while envisioning themselves as future professionals in STEM. In the two semesters in 2024 that offered the new inclusions, "experiments" were noted in 50+% of student responses as one of the best aspects of the unit (Edith Cowan University, 2024).

Additionally, students commented on the engaging "hands on" and practical experience in labs that supported the "understanding of a lot of different areas of science" and "relevance of the topics to real-world science" (Edith Cowan University, 2024). While students were not asked specifically about the Indigenous curriculum inclusions, this was referred to: "I also enjoyed how this unit covers various areas of science rather than focusing on one specific topic with many interesting topics such as the Indigenous medicine module" (Edith Cowan University, 2024). This multi-layered approach to experiential learning creates an inclusive and equitable pathway to STEM education. The action of developing a multi-layered cross-cultural module allowed students to contribute actively to the investigative process, fostering a deeper understanding and appreciation for Indigenous plants' potential medicinal properties and fostering their interest in microbiology. Elevating and showcasing the Aboriginal and Torres Strait Islander science is a way of starting to redress the imbalance in teaching siloed Eurocentric scientific concepts.

Besides the work of Ah Chee et al. (2024) in guiding non-Indigenous educators in respectful curriculum development, other frameworks, university led "Indigenising Curriculum" resources and modules exist. Privileging frameworks and resources that are created by, or co-created with, Aboriginal and Torres Strait Islander people - such as Ah Chee et al., Tracey Bunda (Ngugi/Wakka Wakka) and Katelyn Barney's *Indigenising Curriculum In Practice* podcast, Walter (Palawa) and Guerzoni's foundation principle of Indigenous leadership – five criteria - rather than adopting Westernised versions, upholds the Indigenous and Cultural Intellectual Property (ICIP) of First Nation educators (Ah Chee et al., 2024). Other science collaborations include workshops at Macquarie University, incorporating the Mudang-Dali Indigenous Connected Curriculum Framework within outreach programs. Jamie co-founded the National Indigenous Science Education Program (NISEP) with Elders and fellow chemist Dr. Ian Jamie. These programs, aligned with Universities Australia's Indigenous Strategy (2022) promote cultural immersion, knowledge exchange, and community engagement in science education, fostering knowledge exchange and capacity building *(*Jamie & Jamie, 2023). There are also broader global implications and the transformative impact of such approaches.

Challenges and implications

An important part of "ensuring First Nations Australians can see themselves in the curriculum" is the inclusion, attribution and acknowledgement of Aboriginal and Torres Strait Islander sources, authors and knowledge holders (Ah Chee et al., 2024). In the Science unit curriculum inclusions, and this paper, as per the Indigenous Knowledge Attribution Toolkit and Referencing Guidelines, Aboriginal and Torres Strait Islander sources and Nation/Country/Language have been included where possible/known (Ah Chee et al., 2024; CAVAL, 2023). However, as noted by the Indigenous Health*Info*net "there is no official publication or listing of Aboriginal bush medicines and plant remedies as they vary between different tribes and locations" (2025). Additionally, the intellectual property rights associated with native plants present significant challenges and implications, particularly in ensuring that Aboriginal and Torres Strait Islander knowledge is documented, shared, and protected in culturally appropriate ways. Historical "published" examples Aboriginal and Torres Strait Islander medicinal use of plants have predominantly been written by non-Indigenous authors, in research "about", rather than by, or in collaboration "with" Aboriginal and Torres Strait Islander peoples (AIATSIS, 2022). As such, Indigenous botanical knowledge has been recorded through Eurocentric frameworks, which often fail to acknowledge Indigenous ownership, and the depth of cultural significance embedded in this knowledge. Jamie (2021) highlights the importance of cultural responsibility in scientific research, which has historically positioned Indigenous peoples as research subjects rather than equal collaborators, emphasising the necessity of cultural consultation to avoid overstepping boundaries when engaging with culturally specific contexts. Reflecting on Ah Chee et al.'s positionality continuum for educators, it is recognised that as inclusions in the UniPrep Science module progress and expand, this will need to include cross-cultural collaboration with Aboriginal and Torres Strait Islander community (2024). Additionally, future cohorts will be formally surveyed on the inclusions.

Conclusion

Integrating science curriculum with Aboriginal and Torres Strait Islander science perspectives enhances students' appreciation for diverse ways of knowing and doing. Recognising and valuing Indigenous scientific knowledge fosters a deeper connection to both the subject matter and the broader cultural context in which science operates. This approach not only enriches students' learning but also contributes to a more inclusive and holistic understanding of scientific inquiry. By embedding real-world applications and culturally responsive pedagogy into laboratory teaching, enabling programs empower students to engage with science in meaningful ways. These experiences equip them with the skills, confidence, and perspectives necessary for their academic and professional journeys, reinforcing the transformative potential of Enabling Education in the sciences.

Furthermore, laboratory experiences in Enabling Education provide students with a unique opportunity to develop their scientific skills while fostering a sense of belonging and self-efficacy. By engaging in hands-on, authentic learning, students can see themselves as future scientists, building confidence in their ability to navigate the discipline. The multi-layered nature of these experiences—combining technical skill development, critical thinking, and reflective practice—creates a rich learning environment that extends beyond the lab. By combining hands-on learning with culturally relevant content and an understanding of the epistemology of science, this module provides an inclusive and equitable pathway to STEM education. It empowers students to connect with science through both practical skill-building and an appreciation of diverse knowledge systems, making science accessible and meaningful while supporting their academic and professional aspirations.

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References

Ah Chee, J. (Bundjalung), Bennett, R., Cirkony, C., Coutts, K., Fairbrother, L., Gunning, T., Raven, T. (Yamaji/Nyungar), Sambono, J. (Jingili), Singh, L. (Quandamooka and Wiradjuri), Uink, B. (Noongar), & Ziebell, A. (2024). *A guide for curriculum development: First Nations Australians' science.* Deakin University. https://www.acds.edu.au/wp-content/uploads/A-guide-for-curriculum-development-First-Nations-Australians-Science-Online-v2.pdf

Andrewartha, L., & Harvey, A. (2014). Willing and enabled: The academic outcomes of a tertiary enabling program in regional Australia. *Australian Journal of Adult Learning, 54*(1), 50-68. https://ajal.net.au

Asante, D., Adokoh, C. K., Ameyaw, E. O., Acheampong, D. O., Afrifa-Yamoah, E., Barnes, P., Agyeah, G., Phillips, R., & Sartori, J. (2025). Evaluation of the wound healing and anti-microbial activity of hydroethanolic extracts of young and old leaves of Vernonia amygdalina Delile. *Deleted Journal*, 200221. https://doi.org/10.1016/j.ctmp.2025.200221

Australian Curriculum, Assessment and Reporting Authority (ACARA). (2024). *NAP–Science Literacy 2023 public report*. https://www.nap.edu.au/docs/default-source/nap-sample/nap-sl-2023-public-report.pdf

Australian Institute of Aboriginal and Torres Strait Islander Studies (AIATSIS). (2022). *AIATSIS guide to evaluating and selecting education resources* (p. 15). https://aiatsis.gov.au

Barber, C. R., Palasota, J. A., Steiger, M. A., Bagnall, R. A., Reina, J. C., Wagle, J., & Bai, Y. (2020). Enhancing STEM equity programs with action research. *Action Research, 19*(4), 614–631. https://doi.org/10.1177/1476750320910491

Bergey, D. H., & Holt, J. G. (2000). *Bergey's manual of systematic bacteriology* (2nd ed., Vol. 1). Springer Science & Business Media. https://doi.org/10.1007/978-1-4614-6435-8

Bunda, T. (Ngugi/Wakka Wakka), & Barney, K. (2024). *Indigenising curriculum in practice* [Podcast].https://podcasts.apple.com/au/podcast/indigenising-curriculum-in-practice/id1690575973

Buxton, C., & Lee, O. (2007). Bridging the divide between curriculum theory and practice for nonmainstream students in science education. *Journal of Curriculum and Pedagogy, 4*(1), 39–44. https://doi.org/10.1080/15505170.2007.10411620

Calixto., J.B. (2005) Twenty five years of research on medicinal plants in Latin America: a personal review. *Journal of Ethnopharmacology.* 100, pp.131-134

Carson, C. F., Hammer, K. A., & Riley, T. V. (2006). Melaleuca alternifolia (tea tree) oil: A review of antimicrobial and other medicinal properties. *Clinical Microbiology Reviews, 19*(1), 50–62. https://doi.org/10.1128/CMR.19.1.50-62.2006

CAVAL. (2023). Referencing Toolkit. *CAVAL*. https://www.caval.edu.au/wp-content/uploads/2024/06/CAVAL_Indigenous_Knowledges_Citation_Guide.pdf

Chandorkar, N., Tambe, S., Amin, P., & Madankar, C. (2021). A systematic and comprehensive review on current understanding of the pharmacological actions, molecular mechanisms, and clinical implications of the genus *Eucalyptus*. *Phytomedicine Plus, 1*(4), 100089. https://doi.org/10.1016/j.phyplu.2021.100089

City of Joondalup. (2011). *Plants and people in Mooro Country: Nyungar plant use in Yellagonga Regional Park.* https://www.joondalup.wa.gov.au/wp-content/uploads/2018/07/Plants-and-People.pdf.

Crawford, J., Cowling, M., Ashton-Hay, S., Kelder, J. A., & Middleton, R. (2023). Artificial intelligence and authorship editor policy: ChatGPT, Bard Bing AI, and beyond. *Journal of University Teaching and Learning Practice*, *20*(5), 1-11. https://doi.org/10.53761/1.20.5.01

Cumpston, Z. (Barkandji). (2022). Abundance. In Z. Cumpston, M. S. Fletcher, & L. Head

(Eds.), *First knowledges: Plants, past, present and future* (pp. 71–98). Thames & Hudson.
Cumpston, Z. (Barkandji), Fletcher, M. S. (Wiradjuri), & Head, L. (2022). Personal perspectives. In Z. Cumpston, M. S. Fletcher, & L. Head (Eds.), *First knowledges: Plants, past, present and future* (pp. 16–34). Thames & Hudson.
Cunningham, I. (1998). *The trees that were nature's gift.* Environmental Printing Company.
Department of Education. (2024). *Australian Universities Accord: Final report.* https://www.education.gov.au/download/17990/australian-universities-accord-final-report-document/36760/australian-universities-accord-final-report/pdf
Dianati, S. (2024, July). Indigenising the curriculum: Benchmarking across the Australian higher education sector [Conference abstract]. HERDSA Annual Conference 2024: Together We Innovate, Adelaide, Australia. https://www.herdsa.org.au/conference/herdsa-2024
Edith Cowan University (2024). [Unpublished raw data from student survey].
Fogarty, W., Lovell, M., Langenberg, J., & Herron, M. (2018). *Deficit discourse and strengths-based approaches.* National Centre for Indigenous Studies, Lowitja Institute & ANU.
Gale, T., & Parker, S. (2013). *Widening participation in Australian higher education: Report submitted to the Higher Education Funding Council for England (HEFCE) and the Office for Fair Access (OFFA), England.* CFE (Research and Consulting) Ltd Leicester UK and Edge Hill University Lancashire UK. https://www.deakin.edu.au/__data/assets/pdf_file/0006/365199/widening-participation.pdf
Gale, T., & Tranter, D. (2011). Social justice in Australian higher education policy: An historical and conceptual account of student participation. *Critical Studies in Education, 52*(1), 29-46.
Gibbs, P., Cartney, P., Wilkinson, K., Parkinson, J., Cunningham, S., James-Reynolds, C., & Pitt, A. (2016). Literature review on the use of action research in higher education. *Educational Action Research, 25*(1), 3–22. https://doi.org/10.1080/09650792.2015.1124046
Giuliano, C., Patel, C. R., & Kale-Pradhan, P. B. (2019). A guide to bacterial culture identification and results interpretation. *P & T: A Peer-Reviewed Journal for Formulary Management, 44*(4), 192–200.
Hansen, V. (Noongar), & Horsfall, J. (2020). *Noongar bush medicine.* UWA Publishing.
Head, K., & Cumpston, R. (2022). *Cancer-preventive and antitumour effects of sandalwood oil and alpha-santalol.* In *Materials Horizons: From Nature to Nanomaterials*, 407–421. Springer. https://doi.org/10.1007/978-981-16-6565-3_27
HealthInfoNet. (2025). *Australian Indigenous HealthInfoNet.* Edith Cowan University. https://healthinfonet.ecu.edu.au/learn/cultural-ways/traditional-healing-and-medicine/
Hoch, C. C., Petry, J., Griesbaum, L., Weiser, T., Werner, K., Ploch, M., Verschoor, A., Multhoff, G., Dezfouli, A. B., & Wollenberg, B. (2023). 1,8-cineole (eucalyptol): A versatile phytochemical with therapeutic applications across multiple diseases. *Biomedicine & Pharmacotherapy, 167,* 115467. https://doi.org/10.1016/j.biopha.2023.115467
Hodges, B., Bedford, T., Hartley, J., Klinger, C., Murray, N., O'Rourke, J., & Schofield, N. (2013). *Enabling retention: Processes and strategies for improving student retention in university-based enabling programs*. Office for Learning and Teaching, Department of Education, Australian Government.
Jamie, J. (2021). Macquarie–Yaegl partnership: Community capability strengthening through Western and Indigenous science. *Australian Journal of Chemistry, 74*(1), 28–33. https://doi.org/10.1071/CH20248
Jamie, I., & Jamie, J. (2023). Building meaningful assessment around Mudang-Dali – an

Indigenous-connected curriculum. Abstract from *Australian Conference on Science and Mathematics Education (ACSME)*, Hobart, Tasmania, Australia. https://openjournals.library.sydney.edu.au/IISME/article/view/17432/15039

Jones, A., Olds, A. and Lisciandro, J.G. 2016. “Understanding the Learner: Effective course design in the changing higher education space.” *International Studies in Widening Participation* 3 (1): 19-35.

Jones, M. E., & Smith, T. K. (2019). Colony morphology as a diagnostic tool in bacterial identification. *Journal of Microbiological Methods, 115*, 30-38. https://doi.org/10.1016/j.mimet.2019.04.008

Kairey, L., Agnew, T., Bowles, E. J., Barkla, B. J., Wardle, J., & Lauche, R. (2023). *Efficacy and safety of Melaleuca alternifolia (tea tree) oil for human health—a systematic review of randomized controlled trials. Frontiers in Pharmacology, 14*, Article 1116077. https://doi.org/10.3389/fphar.2023.1116077

Lassak, E. V., & McCarthy, T. (2001). *Australian medicinal plants.* New Holland.

Lisciandro, J. G., & Gibbs, G. (2014). *OnTrack to science literacy: Addressing the diverse needs of non-traditional students engaged in an Australian pre-university enabling program*. In *Proceedings of the 17th International First Year in Higher Education Conference.* Darwin, Australia.

Lisciandro, J., Jones, A., & Geerlings, P. (2018). Enabling learners starts with knowing them: Student attitudes, aspiration and anxiety towards science and math learning in an Australian pre-university enabling program. *Australian Journal of Adult Learning, 58*(1), 112–137.

Lukey, S., Keevers, L., Toole-Anstey, C., Stewart, J., Dodd, S., & MacLeod, L. (2022). Practices and programmes that enhance successful transition and participation in high school for Indigenous young people: A systematic review. *Pedagogy, Culture & Society, 32*(2), 393–413. https://doi.org/10.1080/14681366.2022.2041074

Moon, T., Wilkinson, J. M., & Cavanagh, H. M. A. (2006). Antibacterial activity of essential oils, hydrosols and plant extracts from Australian grown *Lavandula* spp. *International Journal of Aromatherapy, 16*(1), 9–14. https://doi.org/10.1016/j.ijat.2006.01.007

Mostaqim, S., Saha, S. K., Hani, U., Paul, S. K., Sharmin, M., Basak, S., Begum, S. A., Salma, U., & Shahabuddin, M. S. (2019). Antibacterial activities of clove (*Syzygium aromaticum*) extracts against three foodborne pathogens: *Staphylococcus aureus, Escherichia coli,* and *Pseudomonas aeruginosa. Mymensingh Medical Journal, 28*(4), 779–791.

Nieto, G., Ros, G., & Castillo, J. (2018). Antioxidant and antimicrobial properties of rosemary (*Rosmarinus officinalis* L.): A review. *Medicines, 5*(3), 98. https://doi.org/10.3390/medicines5030098

Pearn, J. (2005). The world’s longest surviving paediatric practices: Some themes of Aboriginal medical ethnobotany in Australia. *Journal of Paediatrics and Child Health, 41*(5–6), 284–290. https://doi.org/10.1111/j.1440-1754.2005.00612.x

Purvis, A. J., & Crawford, J. (2024). Ethical standards in social science publications. *Journal of University Teaching and Learning Practice, 21*(9), 1-14. https://doi.org/10.53761/hqnqr710

Savigni, D. L. (2016). Alternative medicines based on Aboriginal traditional knowledge and culture. In Y. Sultanbawa & F. Sultanbawa (Eds.), *Australian native plants: Cultivation and uses in the health and food industries* (pp. 175–221). CRC Press

Suleria, H. A. R., Goyal, M. R., & Sadiq Butt, M. (Eds.). (2019). *Phytochemicals from medicinal plants: Scope, applications, and potential health claims* (1st ed.). Apple Academic Press. https://doi.org/10.1201/9780429203220

Surbhi, Kumar, A., Singh, S., & Kumari, P. (2021). *Eucalyptus*: Phytochemical composition, extraction methods, and food and medicinal applications. *Advances in Traditional Medicine, 23*, 1–16. https://doi.org/10.1007/s13596-021-00582-7

Thomson, S., De Bortoli, L., & Underwood, C. (2016). *PISA 2015: A first look at Australia's results*. Australian Council for Educational Research. https://www.acer.edu.au/ozpisa/reports/

Uink, B., Bennett, R., Hill, B., van den Berg, C., & Rolfe, J. (2022). Interrogating relationships between student support initiatives and Indigenous student progression. National Centre for Student Equity in Higher Education. https://www.ncsehe.edu.au/app/uploads/2022/04/Uink_Murdoch_Final.pdf

Universities Australia. (2022). *Indigenous strategy 2022–2025.* https://universitiesaustralia.edu.au/wp-content/uploads/2022/03/UA-Indigenous-Strategy-2022-25.pdf

Wangchuk, P., Yeshi, K., Vennos, C., Mandal, S. C., Kloos, S., Nugraha, A. S., Tashi, & Samten. (2020). Three medicinal *Corydalis* species of the Himalayas: Their ethnobotany, pharmacognosy, phytochemistry and pharmacology. *Journal of Herbal Medicine, 23*, 100384. https://doi.org/10.1016/j.hermed.2020.100384

Yan, X., David, S. D., Du, G., Li, W., Liang, D., Nie, S., Ge, M., Wang, C., Qiao, J., Li, Y., et al. (2024). Biological properties of sandalwood oil and microbial synthesis of its major sesquiterpenoids. *Biomolecules, 14*(8), 971. https://doi.org/10.3390/biom14080971

Yeshi, K., Turpin, G., Jamtsho, T., & Wangchuk, P. (2022). Indigenous uses, phytochemical analysis, and anti-inflammatory properties of Australian tropical medicinal plants. *Molecules, 27*(12), 3849. https://doi.org/10.3390/molecules27123849

Zerquera, D., Pender, J. T., & Berumen, J. G. (2017). Participatory action research as a social-justice framework for assessment in student affairs. *The Journal of College and University Student Housing, 43*(3), 14–27.