Intercultural understandings in teaching science

A handbook for teachers

Northern Territory Government
Intercultural understandings in teaching science:

A handbook for teachers

Northern Territory Department of Education
1999
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Printed for Publication Services, Northern Territory Department of Education by the Government Printing Office of the Northern Territory.
P&P 99/523-500

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This resource was produced under one of the initiatives in the Northern Territory Department of Education’s Indigenous Education Strategic Initiatives Program (IESIP). This initiative was managed by the Aboriginal Education Branch of the Northern Territory Department of Education and mainly funded by the Department of Employment, Education, Training and Youth Affairs (DEETYA) as part of the National Aboriginal Education Policy (NAEP).
Acknowledgments

Throughout the development of resource materials relating to Australian Indigenous science, Indigenous peoples have made their knowledge freely available for publication. Accordingly, the NT Department of Education

- acknowledges the Indigenous peoples of the Northern Territory as owners of the knowledge
- acknowledges that some Indigenous knowledge may have been used in the past without the direct permission of its owners
- prohibits any further publication without its permission being sought beforehand.

Production of this handbook has been a cooperative project between a number of groups under the umbrella of the NT Board of Studies and the NT Department of Education, including the Science Subject Area Committee and the Indigenous Education Standing Committee. Parts of this handbook were originally drafted by Denine Maddaford as Education Officer Science for ICCAS Materials and Michael Michie in his role as Principal Education Officer Science with the NT Department of Education.
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Introduction

This handbook has been primarily designed to assist non-Indigenous teachers who are teaching science to Indigenous students. However, Indigenous teachers will also find much useful information, especially the descriptions of Western science and how it can be implemented. The handbook focuses on teaching science in Northern Territory schools through

- an examination of the curriculum, resource materials and policies which relate to teaching science

- a description of the ICCAS (Implementing the Common Curriculum in Aboriginal Schools) Primary Science resource materials and how they can be used effectively

- an introduction to Indigenous knowledge and how it can be incorporated into teaching/learning programs.

Other users could be teachers of science in urban schools who want to integrate Indigenous perspectives through science. For this group of teachers an understanding of how to incorporate Indigenous knowledge into their programs would be extremely valuable.

Although this handbook focuses primarily on Australian Indigenous knowledge, there is no reason why knowledge from other cultures cannot be integrated with the science curriculum, particularly in ways which may give an Asian perspective.
Science materials in NT schools: Indigenous perspectives
Science materials in NT schools: Indigenous perspectives

This section focuses on the science curriculum and teaching support materials approved by the Northern Territory Board of Studies for use in all NT schools. We consider some Indigenous perspectives on the teaching and learning of science by Indigenous students by looking at:

- the curriculum—the Science Board Approved Course of Study and the Science Learning Area Statement
- the Science Board Approved Course of Study and Indigenous knowledge
- the ICCAS primary science resource materials
- suggestions for profiling Indigenous students.

CURRICULUM DOCUMENTS

The main curriculum document for teaching science is the Science Board Approved Course of Study, Transition-Year 10 which was released during 1999. The other document which teachers should refer to is the Science Learning Area Statement which was also released in 1999. The learning area statement contains the NT Outcomes Profiles for Science.

The Board Approved Course of Study

The philosophy of the new Board Approved Course of Study in Science is that it will be equally applicable to all students in Northern Territory schools. This is possible because the Science for All idea is part of the rationale of the national statement and profile. The emphasis at the national level has shifted away from content to concepts. For example, rather than proscribing study of the Greenhouse Effect (content), it asks that students describe changes in their environment (a concept) and allows teachers to devise appropriate content. As well, through the Working Scientifically strand there was an integration of the processes of science with the conceptual development of the other strands. These national initiatives have been implemented in the NT in the development of the Board Approved Course of Study.

Indigenous knowledge and Western science explain things from different perspectives or worldviews. A worldview is the set of beliefs, which people of the same culture have, that helps explain their lives. Many people believe that worldviews develop as a child lives in its society. A generalised comparison of worldviews is on page 4, Table 1. The Science Board Approved Course of Study is based on the Western science worldview. It emphasises the ways in which knowledge is gathered through Working Scientifically, the process strand. Besides classifying some knowledge as ‘science’, it further categorises it into the four conceptual strands—Earth and Beyond, Energy and Change, Life and Living, and Natural and Processed Materials. Thus the NT curriculum reflects similar developments taking place throughout Australia.

Figure 1: The science BACOS
However, within this framework there are possibilities for all students to understand that:

- there are many ways of looking at the world
- other worldviews are valid
- the knowledge gained from another perspective can be used to develop intercultural understandings.

The Science Learning Area Statement

This document contains basic information about the course and the outcomes profiles. These profiles are at three levels – a general profile, a foundations profile and a lifeskills profile. The general profile is used when making judgments about student progress. The other two profiles (foundation and lifeskills) apply only to students who are identified as special education students. The foundations profile should not be confused with the Foundation Studies programs for post-primary Indigenous students.

THE BOARD APPROVED COURSE OF STUDY AND INDIGENOUS KNOWLEDGE

One of the aims of the NT Board Approved Course of Study for Science is to consider that worldviews of Western and various Indigenous peoples may be different and therefore scientific knowledge may differ between cultures. Alternative perspectives inform students about how groups use and classify materials, and understand phenomena and relationships in the natural and technological world.

The Board Approved Course of Study makes explicit the need for all teachers, particularly non-Indigenous teachers, to take into account cultural considerations when teaching science. The potential for conflict arises when two worldviews are compared unsympathetically rather than considered as complementary. The potential for ignorance is real if Western science is presented as the only science. This can be avoided through realisation that worldviews are equally valid and are based within the culture. However it is important for Indigenous students to be given access to the full range of Western science, to understand its underlying philosophy (see next section below). Similarly, other students should be given opportunities to develop an understanding of the science of Australian Indigenous Peoples and other First Peoples of the world.

Teachers also need to consider the science teaching/learning model. Western science is based on questioning and discovering answers while Indigenous societies pass on accumulated knowledge. Teachers need to make explicit statements about which perspective is being presented and how other cultural groups have a different set of information.

Indigenous knowledge and Western science

From a Western perspective, science has come to mean ‘seeking to understand and explain the world around us’. Western scientists have done this through observation and experimentation, by classification of things and phenomena, and by explanation derived from previous experience. Western science divides things into parts, looking at the parts to explain the whole, based on reasoning. For some, knowledge is thought of as subject-specific and particularly science knowledge is considered to be universal and culture-free. School science has been taught as fact and scientists portrayed as a superior authority. Much of science and its attendant technology is thought to be prestigious, and there exists a hierarchy of people who have personal access to the higher levels of knowledge because of their positions.
Table 1: Generalised comparison of characteristics associated with Western and Indigenous worldviews.

<table>
<thead>
<tr>
<th>Western worldview</th>
<th>Indigenous worldview</th>
</tr>
</thead>
<tbody>
<tr>
<td>materialistic</td>
<td>spiritual</td>
</tr>
<tr>
<td>reductionist</td>
<td>holistic</td>
</tr>
<tr>
<td>rational</td>
<td>intuitive</td>
</tr>
<tr>
<td>decontextualised</td>
<td>contextualised</td>
</tr>
<tr>
<td>individual</td>
<td>communal</td>
</tr>
<tr>
<td>competitive</td>
<td>cooperative</td>
</tr>
<tr>
<td>explains mystery</td>
<td>celebrates mystery</td>
</tr>
<tr>
<td>time is linear</td>
<td>time is circular</td>
</tr>
<tr>
<td>seeks power over</td>
<td>seeks to coexist with</td>
</tr>
<tr>
<td>nature and people</td>
<td>nature and people</td>
</tr>
</tbody>
</table>

Indigenous peoples have a wealth of knowledges which are actively taught from generation to generation orally, ceremonially, experientially, through art and recently, multimedia. Often this knowledge includes explanations of creation which relate to the traditional beliefs and lifestyles of the people. This is called a holistic approach to knowledge. Indigenous groups in Australia are culturally diverse and do not necessarily share similar understandings. Language often determines the classifications systems which are used by different people. There are often strict rules about who can learn particular information, who owns the information, who can teach it and when people should learn it.

The physicist F. David Peat considered the perceived authority of Western science, and the effect that ‘authority’ can have on the Indigenous knowledge of Native Americans. His comments outline some background understandings for this handbook:

*During the first contact, Europeans were confident that they were the bearers of truth, truth about religions and government, truth about science and law. But today that confidence has been shaken... and science, which has been through two great revolutions — quantum theory and relativity — is much less confident about the nature of objective truth.*

*There are those who still hold that western science can achieve objective knowledge and is in a unique position to teach the truths about the world. The astronomer Carl Sagan, for instance, claims that for the first time in human history we know the truth about the creation of the universe...*

*When Western science claims to be speaking the truth then, by implication, other peoples’ truths become myths, legends, superstitions and fairy stories. A dominant society denies the authenticity of other peoples’ systems of knowledge and in this way strikes at the very heart of their cultures.*

1 Attributes taken from Aikenhead (1998); Kelly, Carlson & Cunningham (1993); Maclvor (1995); and Peat (1994).
Ethnocentrism, the belief that your own culture is inherently superior, can unfortunately stop people from fully appreciating the possibilities of other ways of knowing. As science teachers it is imperative that the content of our lessons and how we teach is culturally appropriate, so that our Indigenous students do not feel the legitimacy of their cultures under threat. We must look for ways to affirm students’ cultures by involving Elders and their knowledge throughout the teaching and learning process.

Is Indigenous knowledge and Western science compatible?

Compatibilities between Indigenous knowledge and Western science are slowly being established and understood. For some Western scientists it has been a process of valuing Indigenous knowledge through the experience of talking and working with Indigenous people. There has been a shift from a position of total disregard for Indigenous knowledge, to comparing it with Western science (valuing how the knowledge is obtained), to a realisation that the understandings are different but compatible because they arise from different worldviews (valuing the knowledge). This process is best illustrated in the ecological sciences. For example, Indigenous knowledge about the uses of plants is considered very valuable by Western scientists (pharmacologists and chemists). An example of the convergence of Indigenous and Western science knowledge in geology is contained in the table below.

<table>
<thead>
<tr>
<th>TWO WAYS OF KNOWING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concept: possible past existence of a large freshwater lake in northern Australia situated where the saltwater Gulf of Carpentaria currently exists.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Australian Indigenous knowledge</th>
<th>Western scientific knowledge</th>
</tr>
</thead>
<tbody>
<tr>
<td>There is information relating to the existence of a large freshwater lake in northern Australia from a number of Indigenous sources:</td>
<td>In the 1980s a group of scientists assembled by Dr. Tom Torgesen (Australian National University) sampled the bottom and took cores of sediment within the Gulf of Carpentaria. Analysis of the cores showed:</td>
</tr>
<tr>
<td>• information from Ngukurr (an Indigenous community 50 km from the coast of the Gulf) tells how the water changed from fresh to salty, and how the people had to learn how to hunt saltwater animals</td>
<td>• changes in the sediments</td>
</tr>
<tr>
<td>• information from Indigenous people living on Cape York (on the eastern side of the Gulf) tells about people walking around a great lake</td>
<td>• changes in the microfauna and microflora</td>
</tr>
<tr>
<td>• Yolngu people from around the coastline of north-west Arnhemland (on the western side of the Gulf) identify a number of sacred sites which occur underwater, both within and outside of, the Gulf of Carpentaria.</td>
<td>which were consistent with the isolation of the Gulf of Carpentaria from both the Arafura and the Coral Seas during the last ice age, and with it being a freshwater lake at that time.</td>
</tr>
</tbody>
</table>

Table 2: The convergence of Indigenous and Western science knowledge in geology: two ways of knowing about the possible past existence of a large freshwater lake in northern Australia.³

Which science should our students be learning?

Education is based on taking a learner from what they know to what they do not know.

- Teachers of Indigenous students learning science need to realise that their students may have understandings of the world which, although they are organised differently to those of other students, are a foundation on which Western understandings can be established.

- Teachers in a Western science environment who incorporate Indigenous studies into their science programs maximise the potential for involvement with Indigenous peoples and their knowledge.

In doing so it is important to explore how access to the two forms of knowledge increases our understanding.

THE ICCAS PRIMARY SCIENCE MATERIALS

This project, Implementing the Common Curriculum in Aboriginal Schools (ICCAS), was funded originally under the Australian Government's Aboriginal Education Program in the 1994-97 quadrennium, and production of materials was completed in 1999. The project funding in primary science originally provided for two education officers, one of whom was an Indigenous person, to develop materials for teachers of middle and upper primary Indigenous students in community schools. Over the duration of the project the composition of the team varied. Much of the development and evaluation of the units was undertaken in workshops involving Indigenous and non-Indigenous teachers from across the Territory. The materials were also considered by the Indigenous Education Standing Committee, a necessary stage in the consultation process before they can be approved by the NT Board of Studies.

A series of 24 titles was produced, nominally at Year 4, Year 5 and Upper Primary (Years 6&7), covering the five strands of the science curriculum (Table 3). The units are teacher resource books and focus on using materials which are readily available in communities. Also, they were written keeping in mind that the students are learning in a foreign language (English), and this was addressed more fully in the later units.

Figure 2: Cover of an ICCAS Upper Primary science unit
Table 3: ICCAS primary science materials and the strands and NT Outcomes Profile levels they cover.

<table>
<thead>
<tr>
<th>Year Level</th>
<th>Title</th>
<th>Strands and NT Outcomes Profile Levels</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Working Scientifically</td>
</tr>
<tr>
<td>Stage 4</td>
<td>Rocks</td>
<td>level 2</td>
</tr>
<tr>
<td>(Year 4)</td>
<td>The Sun, the Moon, the Earth</td>
<td>level 2</td>
</tr>
<tr>
<td></td>
<td>Sounds good</td>
<td>level 2</td>
</tr>
<tr>
<td></td>
<td>Solar energy</td>
<td>level 2</td>
</tr>
<tr>
<td></td>
<td>Caring for the environment</td>
<td>level 2</td>
</tr>
<tr>
<td></td>
<td>Flowering plants</td>
<td>level 2</td>
</tr>
<tr>
<td></td>
<td>Drips and drops</td>
<td>level 2</td>
</tr>
<tr>
<td></td>
<td>Science with food</td>
<td>level 2</td>
</tr>
<tr>
<td>Stage 5</td>
<td>Climate</td>
<td>level 3</td>
</tr>
<tr>
<td>(Year 5)</td>
<td>Mining and minerals</td>
<td>level 3</td>
</tr>
<tr>
<td></td>
<td>Bicycles</td>
<td>level 3</td>
</tr>
<tr>
<td></td>
<td>Flight</td>
<td>level 3</td>
</tr>
<tr>
<td></td>
<td>Plants and their uses</td>
<td>level 3</td>
</tr>
<tr>
<td></td>
<td>Animals and protection</td>
<td>level 3</td>
</tr>
<tr>
<td></td>
<td>Using materials</td>
<td>level 2</td>
</tr>
<tr>
<td></td>
<td>Air</td>
<td>level 3</td>
</tr>
<tr>
<td>Upper</td>
<td>Landforms</td>
<td>level 3</td>
</tr>
<tr>
<td>Primary</td>
<td>Universe and solar system</td>
<td>level 4</td>
</tr>
<tr>
<td>(Years 6&amp;7)</td>
<td>Energy and how we use it</td>
<td>level 3</td>
</tr>
<tr>
<td></td>
<td>Transferring energy</td>
<td>level 3/4</td>
</tr>
<tr>
<td></td>
<td>Adaptations of plants and animals</td>
<td>level 3/4</td>
</tr>
<tr>
<td></td>
<td>Effects of people on the environment</td>
<td>level 3/4</td>
</tr>
<tr>
<td></td>
<td>Sticks become spears</td>
<td>level 3</td>
</tr>
<tr>
<td></td>
<td>What’s the matter?</td>
<td>level 4</td>
</tr>
</tbody>
</table>
Development of the units took place simultaneously with the development of a new NT curriculum (Science Board Approved Course of Study Transition-Year 10 or BACOS) and the NT Outcomes Profile. These in turn relate back to the National Statement and Profile which had been printed when the project started. Thus the units were initiated in an environment which was informed by the national curriculum developments and evolved as the NT Curriculum was being shaped. The strands covered by the units are the same as in the National Curriculum—Earth and Beyond, Energy and Change, Life and Living and Natural and Processed Materials—and Working Scientifically is integrated across the program.

Working Scientifically was seen as a major emphasis in developing the curriculum and it has a high level of emphasis in the course (see page 18). An attempt was made to devise a teaching/learning model based on Working Scientifically, which features in each unit (see Figure 3 below). It also features in the Board Approved Course of Study as the recommended teaching/learning method and links the following steps:

- **focus**—present a problem or a question to focus on; find out what students know about the topic
- **investigate**—plan and carry out investigations; make observations; gather and record information
- **process data**—talk about observations; identify patterns; make conclusions
- **evaluate**—evaluate investigations and findings
- **use science**—apply findings to everyday life and making meaning
- **act responsibly**—use information to make decisions about being responsible in the community.

The level of work in the units was linked to the profile levels (see Table 3 on previous page) and this features in the introduction to each unit.

Figure 3: The science teaching/learning model as it appears in the ICCAS materials.
PROFILING IN SCIENCE WITH INDIGENOUS STUDENTS

Profiling is a way of making judgments about where students are placed in a continuum of understanding. The National Profile and the NT Outcomes Profile for Science both profile conceptual development through Western science, but the starting point of the profiles is equally applicable to both Indigenous and Western students. There is strong emphasis at levels 1 and 2 on the students' understandings about themselves and their location (which is also shared with other learning areas such as Studies of Society and Environment).

The NT Outcomes Profile for Science is based on the National Profile. Through a pilot program it became obvious that the number of outcomes in the National Profile was too numerous, and a decision was made by the NT Board of Studies to reduce them to a workable number. In the science learning area this was done by reducing them to one general outcome for each strand at each level.

The kinds of learning activities that Indigenous students undertake to reach these outcomes may need to be revised (see some examples overleaf). This will ensure that the activities are appropriate to the learners' context. The national statement describes learning experiences for students at each band level, but these are in the context of Western classrooms, and the theme is repeated in the national profile through the large number of examples of how students can demonstrate that they have achieved the outcomes. Both of these have been incorporated into the Board Approved Course of Study, as 'Content' and 'Suggested Activities'. The NT Outcomes Profile for Science lists exemplary materials for making judgments about students, mainly from Student work samples in science (Curriculum Corporation 1996) and the National Profile. Again, these were written with mainstream students in mind and the content may not be appropriate to many Indigenous students because:

- they are product-based, requiring students to produce a report, poster or some other written response when it is the knowledge that should be assessed not the way it is presented (no allowance for assessment through observation and oral questioning)
- they often require a level of literacy (implying English literacy) at an equivalent level to the science outcomes, when many Indigenous students have low literacy but high interest and understanding, and can be disadvantaged by such an approach
- they are often contextually inappropriate, using examples and situations foreign to the students' current life experiences.

The Suggested Activities are useful in two ways, as suggested teaching/learning activities and as assessment activities. Although some of them may be more appropriate for urban learners, they give teachers an idea of the expectations at that level. This is also true for the examples, which can be deconstructed so that teachers can prepare their own assessment items to make judgments.

Following is a list of suggested activities for levels 1 and 2, written for an Indigenous context. They were written by a non-Indigenous educator during a short visit to an Aboriginal community, so they do not necessarily reflect Indigenous knowledge but rather attempt to be inclusive of students' worldviews and needs. Educators need to actively seek to develop understandings about science through valuing their own position as a learner.
**Table 4:** Suggested activities for achievement of Level 1 Outcomes Profiles for Science with Indigenous students.

### Earth and Beyond

**Level 1**

*Students identify features of their environment.*

<table>
<thead>
<tr>
<th>Activity</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>- lists ways the local environment influences daily life</td>
<td>Observes changes in the weather pattern from season to season.</td>
</tr>
<tr>
<td></td>
<td>Talks about things that happen in the community during different seasons.</td>
</tr>
<tr>
<td></td>
<td>Talks about why they do things a particular way according to the season.</td>
</tr>
<tr>
<td>- distinguishes major features of the physical environment</td>
<td>Distinguishes features of the local landscape such as mangroves, beaches, bush.</td>
</tr>
<tr>
<td></td>
<td>Distinguishes between natural and human features e.g. airport, town, roads.</td>
</tr>
<tr>
<td>- identifies features of the day and night sky and relates them to patterns of behaviour in everyday life</td>
<td>Describes daily routines.</td>
</tr>
<tr>
<td></td>
<td>Identifies animals that are active by day and animals active at night.</td>
</tr>
<tr>
<td></td>
<td>Talks about different star patterns visible during the year.</td>
</tr>
</tbody>
</table>

### Life and Living

**Level 1**

*Students identify the needs of plants, animals and environments.*

<table>
<thead>
<tr>
<th>Activity</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>- identifies personal needs and the needs of other familiar living things</td>
<td>Lists sources of food and shelter for local animals.</td>
</tr>
<tr>
<td>- identifies observable personal characteristics and those of other familiar living things</td>
<td>Describes life cycles of frogs and other familiar animals.</td>
</tr>
<tr>
<td>- identifies personal features and those of plants and animals that change over time</td>
<td>Talks about changes to plants from wet season to dry season.</td>
</tr>
</tbody>
</table>
## Energy and Change

**Level 1**  
*Students identify energy sources and uses in everyday life.*

<table>
<thead>
<tr>
<th>Task</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>describes ways energy is used in daily life</td>
<td>Explores ways Indigenous people used to light fires, keep cool in the wet season or keep warm in the dry season. Talks about the kinds of shelters traditionally used, in terms of heating and cooling.</td>
</tr>
<tr>
<td>describes sequences of connected events</td>
<td>Lights a fire and talks about the steps while doing them.</td>
</tr>
<tr>
<td>identifies sources of energy in everyday life</td>
<td>Identifies sources of energy in the community.</td>
</tr>
</tbody>
</table>

## Natural and Processed Materials

**Level 1**  
*Students identify that the particular uses of different materials.*

<table>
<thead>
<tr>
<th>Task</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>identifies materials and their uses</td>
<td>Talks about what materials are used for various traditional objects.</td>
</tr>
<tr>
<td>identifies properties of materials using the senses</td>
<td>Identifies the best kinds of wood for making a fire.</td>
</tr>
<tr>
<td>identifies changes in materials using the senses</td>
<td>Talks about what happens as a fire burns.</td>
</tr>
</tbody>
</table>
Table 5: Suggested activities for achievement of Level 2 Outcomes Profiles for Science with Indigenous students.

### Earth and Beyond

**Level 2**  
*Students describe changes in their environment.*

<table>
<thead>
<tr>
<th>Activity</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>• records ways we monitor and use information about changes to the Earth</td>
<td>Investigates the local Indigenous seasonal calendar.</td>
</tr>
<tr>
<td></td>
<td>Investigates how the sewerage system works and helps to prevent disease.</td>
</tr>
<tr>
<td></td>
<td>Talks about how Indigenous people use fire during the year.</td>
</tr>
<tr>
<td>• describes changes that occur in local environments</td>
<td>Talks about changes to a beach during the year.</td>
</tr>
<tr>
<td></td>
<td>Describes changes that have taken place in the community in the past 20/50/100 years (e.g. from photos, old people).</td>
</tr>
<tr>
<td>• investigate the apparent motion of the Sun in relation to the Earth and how this affects everyday life</td>
<td>Investigate seasonal events—plants, animals, rain, hotness and coldness.</td>
</tr>
</tbody>
</table>

### Life and Living

**Level 2**  
*Students describe living things, including their features, life cycles and interactions.*

<table>
<thead>
<tr>
<th>Activity</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>• describes the types of relationships between living things</td>
<td>Describes how local animals depend on plants or other animals for food.</td>
</tr>
<tr>
<td>• links observable features to their functions in familiar living things</td>
<td>Researches how a kangaroo uses its tail; how different shaped beaks force birds to eat different foods.</td>
</tr>
<tr>
<td>• compares and contrasts similarities and differences within and between groups of living things</td>
<td>Talks about local plant and animal classifications.</td>
</tr>
</tbody>
</table>
## Energy and Change

**Level 2**  
*Students describe the ways energy is used, identifying energy changes.*

| Explains the ways people in the community use energy | Investigates the ways energy is used by different people.  
Talks about different kinds of buildings and how people keep cool. |
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Describes the properties of light, sound, heat and movement</td>
<td>Investigates the sounds made by traditional musical instruments and how they can be varied.</td>
</tr>
<tr>
<td>Describes observable changes which occur when two objects interact</td>
<td>Cooks food and describes the process orally and/or in pictures.</td>
</tr>
</tbody>
</table>

## Natural and Processed Materials

**Level 2**  
*Students describe materials and their uses according to their observable properties.*

<table>
<thead>
<tr>
<th>Lists how materials are used for different purposes</th>
<th>Investigates the ways different plants can be used.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Describes the substructures of some common materials</td>
<td>Examines some bush resources and how they are used (e.g. paperbark, ironwood).</td>
</tr>
<tr>
<td>Distinguishes between changes that cannot be readily reversed and those that can</td>
<td>Talks about the changes when processing cycad nuts, cooking bread.</td>
</tr>
</tbody>
</table>
Intercultural science teaching in Northern Territory schools
Intercultural science teaching in Northern Territory schools

In this section we consider some of the cultural and pedagogical implications of teaching science to Indigenous students, given the differing worldviews of non-Indigenous teachers, Western science and Indigenous students. We also look at some issues in teaching Indigenous knowledge in urban schools and the role of science in promoting literacy and numeracy.

INTERCULTURAL SCIENCE TEACHING

In this handbook we use the term 'intecultural' when referring to the understandings required of teachers working with Indigenous students. This is used rather than the more commonly known concept of 'cross-cultural'. As intercultural science teachers, we should be assisting our students to access Western scientific knowledge while having some understanding of the differing worldviews of our students (see Table 1 on page 4). If we do not acknowledge the worldviews of our students and insist on teaching them as though they share our Western perspectives, we will be failing them as educators and will most probably demean and devalue their cultures. In cross-cultural teaching, we believe that a less holistic approach is often taken, with teachers merely using an alternative culture as a resource for the exotic. This may lead to negative judgements of the students' culture when compared to the dominant Western culture. Professor Glen Aikenhead of the University of Saskatchewan in Canada has written extensively about such issues in teaching science to Indigenous students:

Because the culture of Western science can conflict with the cultures of Aboriginal students, learning Western science requires Aboriginal students to cross cultural borders... Because science tends to be a Western cultural icon of prestige, power and progress, it can threaten Indigenous cultures... science instruction can disrupt the student's view of the world by forcing that student to abandon or marginalise his/her Indigenous ways of knowing...

How does one nurture students' achievement toward formal educational credentials and economic and political independence, while at the same time develop each students' cultural identity as an Aboriginal person? One answer is an integration of Aboriginal knowledge into science education for the survival and well being of Aboriginal peoples.4

We should embed our students' cultures into the science teaching we do with them. This is most easily done through involving Elders or Indigenous teachers/assistant teachers in the planning and teaching of science. They may, for example, be able to suggest an appropriate cultural belief or practice as a starting point for learning about a Western science concept. They will help to ensure that inappropriate content and teaching styles will be minimised. Their presence will assist in the 'culture broker' role that all teachers must take, as Indigenous students move from their home cultures to the cultures of school and science.

TEACHING SCIENCE IN INDIGENOUS SCHOOLS

All learners come to school with skills and understandings of the world around them. Their skills and understandings are a starting point from which good teachers will begin developing their own programs, but there may be difficulty in determining where students are at. Some issues which may arise with Indigenous students are:

- **language**: teacher and student do not speak the same language (or the student does, but as a second language)

- **context**: the teacher may not understand the context of the learner and is unable to scaffold learning appropriately to what the learner already knows

- **culture**: the teacher may not understand that there are cultural differences between the learner and themselves, for example: in the areas of asking and responding to questioning; appropriate ownership of the knowledge

- **learning styles**: the teacher may not be familiar with some of the ways Indigenous students prefer to learn; students may have many experiences of their environment as independent learners; many Western ways of teaching and learning (for example, questioning, making eye contact) can be culturally inappropriate. These issues are not restricted to teaching and learning science.

Implementing the science course in Indigenous community schools is highly valuable for the students. Science provides a context through which literacy and numeracy development can take place. The ICCAS Primary Science materials (which are described on pages 6+ and 39+) provide an approach to address literacy in particular. They are written with ESL learners in mind and use appropriate language strategies throughout (some ESL strategies appropriate for science teachers are reprinted on page 23).

Indigenous students often have well-developed knowledge of their environment, making it a suitable basis for developing further knowledge. There is a view that Indigenous students have this knowledge as if it was an intrinsic part to being Indigenous, but it is being found that this is not always the case. It is important to scaffold Western understandings on what students already know, and to do this teachers need to be able to determine what it is students know.

As Indigenous people interact with Western cultures and technologies, there is a need that these experiences be empowering. Although Western explanations may conflict with those of Indigenous people in some contexts, there are many areas where there are no alternative explanations. Indigenous people themselves want to learn about the Western ways and the term, ‘two-way learning’, has been used to describe this process.
Although Working Scientifically is a new process strand in the curriculum, the idea of ‘working scientifically’ is not new. Indigenous people developed ways of understanding their environment and techniques and technologies for dealing with it over a period of time. What we see now is the result of developments over a long period of time within the context of their environments. The accounts of these developments usually reflect learning passed on from generation to generation, rather than the initial discoveries and their refinements. Some of these discoveries by Australian Indigenous people include:

- highly developed pharmacologies (the preparation and uses of drugs in ‘bush medicines’)
- the detoxification of cycads and other foods
- land management using fire (‘firestick farming’)
- development of sophisticated seasonal calendars (see page 30)
- production of a range of boomerangs and other weapons.

There is increasing evidence that Australia’s Indigenous peoples have had to adapt to changes which took place in their environments well before the invasion by Europeans. Art sites such as those in the Kakadu region indicate that major environmental changes took place there. Changes in environments lead to changes in the plants and animals which provide food, and in the technologies used.

Indigenous people have always judged new ideas and products, and accepted or rejected them, or made changes as they see fit. These judgements are often attributed to ‘trial and error’, but they represent conscious decisions made on the basis of systematic and scientific trialling. For example, Indigenous Australians have done this by:

- production of dugout canoes inspired by Macassan canoes
- choosing to use glass and porcelain from electrical insulators for blades and arrow points, rather than stone
- deciding to continue to use ironwood instead of steel in shovel-nosed spears used for hunting buffalo.

The process of Working Scientifically introduces to all students the Western scientific approach of acquiring knowledge. It does this through several formal steps, of testing, experimentation or investigation. In the model, the steps are:

- focus—present a problem or a question to focus on; find out what students know about the topic
- investigate—plan and carry out investigations; make observations; gather and record information
- process data—talk about observations; identify patterns; make conclusions.
- evaluate—evaluate investigations (for fair testing) and findings (for what has been learnt).

In the NT science curriculum, Working Scientifically also includes the abilities to:

- use science—apply findings to everyday life and making meaning
- act responsibly—use information to make decisions about being responsible in the community.
All students of science should have hands-on experiences, using materials to make observations and for experiments. The materials they use do not have to be sophisticated, and the emphasis should be on how the students' senses can be extended. The types of materials students should be using are listed elsewhere in this handbook (see page 44). Many of the experiences suggested in the ICCAS materials involve using everyday materials and are good starting points for experiments. Other books describe experiments using particular pieces of equipment; it is often possible to substitute everyday items. There are some scientific instruments which all students should experience, including thermometers, magnets, magnifying glasses or hand lenses, and microscopes. Some of these can be acquired reasonably easily by schools and possible sources are listed.

The types of hands-on experiences should be relevant to the students. Particularly when dealing with animals, plants, rocks, minerals or shells, make sure to use examples from the local area. Remember that with some materials, the students will have names in their language and alternative classifications, so it is important to consider that there are ways other than the Western scientific way of looking at the world. In the ICCAS materials, check out the Cultural Considerations section, where there is the possibility of different understandings. Western teachers in community schools could plan these activities with their assistant teachers.

With many hands-on resources, students need opportunities to understand how they work. Depending on the object's fragility, students should be given an opportunity to play beforehand, then instructed on how it can be best used. Objects such as thermometers and microscopes need to be treated carefully, so instruction on their use needs to be more directed. Teachers also need to know how things work, so if you are unsure, then seek help from other teachers or people in the community. Health workers usually know how to use thermometers and could have experiences with microscopes.

Many hands-on experiences can be had by undertaking excursions. Excursions are any visits outside of the classroom, so can be to somewhere else around the school, elsewhere in the community (e.g. health centre), on community lands or beyond the community. Excursions on community lands should be undertaken with assistance from the traditional owners, to ensure a meaningful context for the science learning, as well as to ensure that customary law is maintained. Extended excursions beyond the community take a lot of time to organise. Get help from other people in the community, some of whom may be willing to go on the excursion.

Videos, television programs, CD-ROMs and the internet can be very helpful in teaching science. Often they will show students experiments which cannot be done in a classroom or model Western scientific explanations. Some programs use language that students find difficult to understand, so it is best for teachers to watch the program first, so they can explain some parts to the students. Often there will be a Western scientific explanation which differs from the local explanation. Students should be made aware that there are other ways of explaining the world. Sometimes these situations can be discussed in class. An alternative is for students to make their own videos that can be shown to students in later years or shared between communities.

5 Experiments often show students heating liquids in beakers using flames. In general, it is not possible to substitute ordinary glass containers where they have to be heated.
The policy of the NT Board of Studies is that all students enrolled in NT schools have the opportunity to undertake Australian Indigenous Studies (in some form) across the curriculum. The Science Curriculum therefore encourages teachers to incorporate Indigenous perspectives where appropriate in programs for Western students. In the NT, this group of students includes many from a wide variety of cultural traditions. One of the aims of the NT Science Curriculum is to promote consideration of differing worldviews, not just to enrich Western science, but to develop intercultural understandings. Western students should be challenged, through the curriculum, to engage in ways of knowing which differ from that of their own worldview.

What may become apparent when investigating various worldviews is that there may be overlaps of what is considered important by Western and Indigenous people (for example, see Table 7 on page 32). Comparison between Indigenous and Western people of their knowledge on many topics would indicate that there was:

- knowledge which is important to both Indigenous people and Westerners
- knowledge which is important only to Indigenous people
- knowledge which is important only to Westerners.

Indigenous people have also expressed that they need to know more about Western ways, a process which has been described as ‘two-way learning’.

Already in our classrooms, many people have attempted teaching about bush tucker, bush medicines and knowledge of the seasons. Typical approaches have included:

- what it is—identification and classification
- what you do with it—uses, cooking, processing
- when it can be found—seasonal variation
- where is it found—habitats.

What is also needed is an examination of deeper understandings about the peoples and establishing a link to their cultures. There is increasing interest in incorporating Indigenous perspectives as a way of teaching about culture and worldviews.

**Australian Indigenous Studies**

The Australian Indigenous Studies Curriculum Policy of the NT Board of Studies requires that all students enrolled in NT schools have the opportunity to undertake Australian Indigenous Studies. There are specific knowledge and understanding outcomes which are applicable to science, including

- Australia’s Indigenous cultures are dynamic, living cultures
- Australian Indigenous peoples have always developed and adapted technologies—in the sense of tools and social arrangements—to meet their needs
Australian Indigenous peoples' traditional ways of classifying and using the natural environment are increasingly recognised as alternative and valid sources of knowledge of the Australian continent and surrounding seas.

Australian Indigenous cultures are diverse; Australian Indigenous languages are diverse and the language and culture of any group of people are always interrelated.

Australian Indigenous individuals and communities continue to value their ancestral stories and oral traditions very highly.

The relationship Australian Indigenous peoples have with their land, sea and water systems forms the basis of their spiritual and social relationships.

There are many different approaches to teaching and learning science, but there is a common thread to science education: no one person can know all about science. No matter what the approach, the reality of the situation is that any science course presents a 'snapshot' of science. The philosophical underpinning of one approach to science is called Science for all. This philosophy focuses on the cultural and human context of science, as well as promoting participation in science by all students. However, inclusivity is not simply including minorities in learning but rather a recognition of, and understandings about, diversity. A major outcome is the understanding that there are other ways of looking at the world.

**Other cultures: Studies of Asia in NT Schools Policy**

The NT Board of Studies policy on Studies of Asia focuses on the regional orientation of Australia in the Asia-Pacific region, as well as the long association with people in the region. The study of science in NT schools can enable students to develop and critically apply understandings, skills and attitudes about Asia's societies and environments. Some aspects of science, particularly understandings about the range of environments, human impacts on them and ecologically sustainable development, can be undertaken using examples from Asia in their cultural context.

The history of Western science is grounded on many discoveries and innovations having their origins in Asia. It is useful for students to realise that this is the case. Asian scientists continue to make contributions to Western science, while the importance of knowledge of Indigenous peoples throughout Asia is starting to be recognised and valued. Traditional values and ways of thinking still dominate the lives of many people in Asia.
Currently in Australia, there exists a determination at all levels of government to see improvements in literacy and numeracy outcomes for students. This is especially significant for Indigenous students, many of whom will be English as Second Language speakers. Science activities can be a very motivating and fun way to practise literacy and numeracy skills. For example, genres such as explanation, report and recount can form part of the science method, both orally and in writing. Doing science often involves numeracy through the counting and measuring of variables such as time, distance and weight.

Science activities are interesting, practical and shared... an ideal context for language development. This should not surprise us, as people learn language best when they are motivated, and interesting things motivate. They learn language best when they are engaged, and practical activities engage. They learn language best when they work together, and shared tasks involve this.

An activity approach allows children who are operating at different levels to benefit from time spent together, as they take from each activity, and from the surrounding talk, those things which they can assimilate. Properly structured activities will encourage the use of particular areas of language, and the less adept children will take up the language used by the more confident. 6

The ICCAS Primary Science materials suggest explicit ESL strategies to assist the teacher in achieving science learning with their Indigenous students. The best time for students to learn the language of science is by using it while doing science. In addition, key language structures and language features (e.g. question forms, giving reasons, expressing contrasts) and possible genres are suggested for each science activity. All the ICCAS materials include a vocabulary section listing the words that relate to the particular science activity. Students need to understand the scientific and everyday meanings of words to do the activities successfully. Following is the list of ESL strategies appearing in the ICCAS materials.
ESL Strategies for Science Teachers

In using the Science Teaching/Learning Model with Indigenous students, teachers should incorporate ESL strategies where appropriate into the learning sequence:

- respect students' first language, background knowledge and science concepts
- expect that students will learn (teacher expectation has a profound impact on student performance)
- provide opportunities for students to talk about science concepts in English
- make sure students understand the purpose of science activities and encourage them to discuss what they are doing and why
- encourage students to do and say things for themselves
- check the Vocabulary section of each science activity for any new words
- use these new words before, during and after the science activity
- present new vocabulary through shared experiences, using concrete objects or pictures
- use the language of science when the students are doing science
- help students to explore and practise the English language from shared experiences
- be good models for oral language
- be good models by recording in writing
- provide plenty of scaffolding in the beginning stages
- provide opportunities for repetition
- review, repeat and revisit situations and experiences so that students can revise vocabulary and add to it
- use science activities to encourage the risk-taking involved in using 'new' vocabulary
- use real-life contexts, examples and materials whenever possible
- make sure students work in pairs and small groups so they can help one another and feel secure enough to take risks
- present work in multi-sensory ways, e.g. visual, aural, touch and smell
- allow time for students to comprehend, respond, memorize and learn
- allow time in their programs for individual efforts in speaking and writing
- give students confidence by
  - setting achievable tasks
  - working at a pace that suits the students
  - giving constant positive reinforcement and encouragement
  - working orally before expecting written texts
  - working from known to unknown situations
  - working from simple to more complex concepts
  - working from whole to parts to whole
  - working from concrete to abstract
- assess students understandings in a variety of ways.

Students often prefer to
- learn by observation and imitation rather than by verbal instruction
- learn by personal trial and error rather than by verbal instruction with demonstration
- learn in real-life settings rather than by practice in artificial settings
- learn context-specific skills rather than generalised principles.
Understanding Indigenous knowledge
Understanding Indigenous knowledge

Many students in the Northern Territory are Indigenous Australians and many grow up with a different worldview to that of Western science. Table 6 on the next page outlines the basis of Indigenous peoples’ understandings of the world. Some examples are given below to help you understand some of the differences between Indigenous knowledge and Western science. The first example, Organisation of knowledge, was written for the first edition of this handbook. The message is still valuable. It tells of how one Indigenous group, the Yolngu of Milingimbi in Northeastern Arnhemland, organise their knowledge and the language they use to describe it.

ORGANISATION OF KNOWLEDGE

People have many ways of organising knowledge. One way scientists organise knowledge is to give all plants and animals a scientific name and then group together the ones which are alike. For example, lyrebirds, larks, swallows, cuckoo-shrikes, wrens, honeyeaters, pardalotes, finches, figbirds, magpie larks, crows and several other families of birds are grouped together and called the order of perching birds. They are all songbirds and are alike in several other ways as well. For example, they have three similar unwebbed front toes and a well-developed hind toe which is not reversible. One of the families which make up the order of perching birds is called the family of finches. This family includes Poephila personata, Poephila acuticauda and Poephila bichenovii. These three birds all share the same first name because they all belong to the same genus. Not many people would recognise these birds from their scientific name and so, like many plants and animals, they have a common name as well. The common names for these three birds are Masked finch, Long-tailed finch and Double-barred finch. The Yolngu of Milingimbi also know these three finches but do not give them each their own name. They do, however, recognise these birds as one group which they call lidjilidji in their language Gupapuyngu.

![Diagram of Yolngu classification]

Figure 4: Yolngu classification groups together as Lidjilidji, three species of finches that Western science sees as different.

Scientists try to give everything a name. Indigenous people usually only give a specific name to those things which have a special use or are significant to them in some way.

### Table 6: A summary of Indigenous peoples’ understandings of the world (worldview)

<table>
<thead>
<tr>
<th>Holistic versus a reductionist approach</th>
<th>Indigenous people examine elements of their surroundings in terms of how they relate to each other.</th>
<th>For example, the notion of the seasons only makes sense when considered with the movement of the animals, growth of plants, movement of water. There is a relation between each element. An Indigenous view moves beyond simply examining the wind, clouds and temperature.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ecologically based approach</td>
<td>People are a part of the environment. Their actions directly impact on the flora and fauna. People are in and not external to their environment. There is a connectedness with nature and each other rather than the view that nature can be controlled.</td>
<td>The gathering of food or hunting of animals is based on present needs of its people, within the context of ensuring scarce resources will be available in the future. For example, a waterhole is important and must be cared for and not depleted.</td>
</tr>
<tr>
<td>Inclusive versus the specialisation of knowledge</td>
<td>Everyone understands and uses science and technology (but with certain members of the community claiming knowledge of it) as opposed to specialist knowledge held by a limited few.</td>
<td>An understanding of where to find water is traditionally held by all members of traditionally oriented communities. Similarly, the process of hunting for kangaroos (tracking, signing to indicate direction) is known to all, although aspects of this task may be performed by only some.</td>
</tr>
<tr>
<td>Knowledge is spiritually framed</td>
<td>Art, dance music and dreamtime stories link knowledge with the land and its people.</td>
<td>For example, an understanding of day and night may be closely linked with the dreamtime. Stories link people and nature together, and provide a vehicle for passing on cultural knowledge from adults to children.</td>
</tr>
<tr>
<td>Contextualised versus decontextualised science</td>
<td>Knowledge is developed and used in context. Scientific enquiry takes place in the everyday situation and not in an environment external to the context in which it will be applied (laboratory).</td>
<td>For example, knowledge of fire lighting is developed as a result of materials available, e.g rubbing sticks over dried grass; using pandanus leaves to make string.</td>
</tr>
</tbody>
</table>

---

The Yolngu of Milingimbi have a highly structured system of classifying plants and animals. Like the scientists' taxonomy, the Indigenous taxonomy groups things in levels where each higher level includes all the ones lower down. The finches called *lidjilidji* are one of the groups which make up the category of small birds called *djikay*, which in turn is part of the total group of birds called *warrakan*.

![Figure 5: Part of Yolngu classification structure for birds.](image)

As can be seen in Figure 5 above, *warrakan* can be used to mean all birds as well as large birds only. It is quite common for words to have different meanings at various levels in the Arnhemland Indigenous taxonomy. In some cases Indigenous classes are equivalent to scientific classes. For example, *gurrutjutju* is the name of the group of all hawks and falcons which occur in Arnhemland. *Gurrutjutju* is also the name of the Whistling Kite at the specific level. This could be called an Indigenous scientific classification.

Within Indigenous classification there are several levels of knowledge which can generally be delineated by age groups. *Warrakan*, for example, is used by children up to 10 years of age to refer to large birds, in contrast to *djikay* which refers to small birds. From 11 to 18 years, *warrakan* is used to refer to both large and small birds. From 19 to the early 30s *warrakan* refers not only to all birds but mainly to large edible birds classified by their habitat from sea to bush. Older persons use *warrakan* to refer to large land animals, reptiles, bats, echidnas, birds.

Similarly *miyapunu* is used by children up to 5 years of age to refer only to the flat back turtle. From 6 to 10 years of age, children refer to all species of turtles as *miyapunu*. From ages 11 to 16, *miyapunu* refers to all turtles and dugongs. From ages 17 to 23, *miyapunu* becomes turtles, dugongs and dolphins. After 23 years of age whales are included as *miyapunu*, but only by men, as they become part of religious knowledge.
In the same way that most Western people prefer to use common names for plants and animals in everyday social situations rather than complex scientific names, Indigenous people in Arnhemland also use names in ways other than the strict scientific sense. Warrakan, as we have seen above, is often used to refer to animal meat rather than large birds, so that beef is warrakan in the sense that it is edible raw meat. Another example is ngatha which is generally used to mean all food. However, in the strictest sense it means only root crops such as the various types of yams, while borum refers to crops which fruit above ground. These are examples of social classifications.

There is one further way in which Indigenous people in Arnhemland classify knowledge. Religious categories may recognise many of the same things as the scientific categories, but label them in a different way. Many plants and animals, for example, possess a subsection and hence a moiety which detail relationships and ownership by particular clans. For example, Damala, the White-breasted sea eagle (Haliaeetus leucogaster) is Gamarrang subsection of Yirritja moiety and is owned by the Murrungun clan, while Wawak the Giant water lily (Nymphaea gigantea) is Bangadi subsection of Yirritja moiety and is owned by Ganalbingu clan. The religious knowledge and ceremonies attached to these plants and animals are the responsibility of the people of the same clan as the plant or animal in question. Clans then combine in song cycles, where each clan sings their portion of the cycle. This can involve plants, animals, tracts of land or events which they own. Some information in religious categories is open to all people, but much is considered restricted and sacred by Indigenous people and will not be further mentioned here.

Indigenous people have complex classificatory systems which can illustrate the structure of their worldview. These classificatory systems are not restricted to plants and animals. For example, seasonal cycles are found to be relevant to and characteristic of all groups of Indigenous people in all environments. Diagrams of such cycles (like that pictured on the following page from Milingimbi) are highly simplistic because they are dissected from the holistic system of knowledge in which they are embedded. Such illustrations serve as beginning sketches to help educators from a Western science tradition understand that there are other systems of knowledge.
THE SEASONAL CYCLE AS A CURRICULUM FRAMEWORK

The seasonal calendar can be the focus of developing a local curriculum. The key events and activities within the cycles shown on a seasonal calendar (Figure 7) can be used as the starting point for a community-based science program (Figure 8). The diagram is not intended to represent a full year's teaching program. It is simply intended to show how seasonally determined activities can form the starting points leading on to development of progressively more complex scientific concepts.

Figure 7: Seasonal Calendar from Milingimbi.9

The principal advantages gained from such an approach are:

- in selecting topics for study, the teacher is able to capitalise on the interests of the community at a particular time
- this approach ensures that learning activities in the classroom are relevant to the students' activities outside those four walls and to the daily conversations in the camp at the time
- any lack of scientific materials and equipment can be counteracted by the thoughtful use of specific local resources as they become seasonally available
- it develops dialogue with the community and actively acknowledges Elders as valued experts, while supporting student learning.

Figure 8: Possible community based science program for Milingimbi.¹⁰

Comparison of the knowledge on many topics between Indigenous and Western people would indicate that there was

- knowledge which is important to both Indigenous people and Westerners
- knowledge which is important to Indigenous people
- knowledge which is important to Westerners.

For instance, knowledge about crocodiles can be subdivided using this strategy:

<table>
<thead>
<tr>
<th>KNOWLEDGE ABOUT CROCODILES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Important to Indigenous people</td>
</tr>
<tr>
<td>crocodiles are common in Indigenous laws</td>
</tr>
<tr>
<td>crocodiles are totems for some people</td>
</tr>
<tr>
<td>the first crocodiles travelled across Arnhemland and created the landscape</td>
</tr>
<tr>
<td>crocodiles are Yirritja moiety</td>
</tr>
<tr>
<td>crocodiles have crocodile dances</td>
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</tbody>
</table>

Table 7: Subdivision of Indigenous and Western knowledge about crocodiles.11

The above table is simplified and ignores the obvious interests of Western scientists who happen to be Indigenous. Further analysis of the Western knowledge about crocodiles would put it into a number of categories: classification; seasons; habitats; uses; processing; behaviour; and reproduction. There are several other categories of Indigenous knowledge: ownership of knowledge and the law; land ownership; ceremonial; links to ancestral beings; relationships between people and crocodiles. Western science includes some processes in common with Indigenous knowledge, but Indigenous knowledge has a range of holistic links that are not present in Western science.

So Indigenous knowledge is generally holistic, making no artificial boundaries between types of information. Western knowledge is dissected into subject areas (in this case, science) and the NT curriculum dissects it even further into the four strands. This organisation of knowledge into subjects is a Western construct, rather than an Indigenous one. Table 8 below outlines the different approaches taken by the two knowledge systems to the origin and acquisition of the concept of landforms, which formed the basis of the ICCAS Upper Primary science unit, Landforms. They appear almost completely incompatible and yet, as we have seen previously, many links can be made (see page 5). These different explanations result directly from the different worldviews of the owners of the knowledge (see Table 1 on page 4 and Table 6 on page 27).

<table>
<thead>
<tr>
<th>Concept: Landforms</th>
<th>Australian Indigenous knowledge</th>
<th>Western scientific knowledge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explanation</td>
<td>Results from the effects of religious events in the Dreamtime. For example, the actions of the Rainbow Serpent travelling across the land.</td>
<td>Results from the effects of erosion. For example, the effects of wind, the movement of water in rain and rivers and heating from the sun.</td>
</tr>
<tr>
<td>Evidence</td>
<td>Comes from stories, songs and dance.</td>
<td>Comes from observations, theories, predictions and experimental confirmation.</td>
</tr>
<tr>
<td>Available to</td>
<td>Particular people who are related to that land and own the knowledge. Others can be aware but will not claim the knowledge publicly.</td>
<td>Anyone who is able to access it and has some background science knowledge.</td>
</tr>
</tbody>
</table>

Table 8: Comparison of the origin and acquisition of Australian Indigenous knowledge with Western scientific knowledge about landforms.12

In regard to teaching the Western scientific knowledge of landforms, it is suggested in the ICCAS materials that initially, Indigenous students should investigate their own culture’s knowledge of landforms. This is to assist the students in finding a starting point for new learning. Involvement of Elders and other community members in both the planning and teaching of such a topic is vital. This will ensure relevance to the students’ lives and that the knowledge covered (both the Indigenous and Western) is culturally appropriate. Teachers must not attempt to compare or judge the relative merits of the knowledges. Both knowledge systems exist in Indigenous communities and both have a role to play.

Protocols for working with Indigenous people
Protocols for working with Indigenous people

Indigenous teachers teaching in community schools

Indigenous teachers working in community schools usually share the same culture as their students and generally know how much Indigenous children know about a subject at a particular age. They can expect to

- be the person to consult with the community and especially older Indigenous people on behalf of the school
- be responsible for cultural knowledge and advise as to what information children are allowed to know
- consult with the Indigenous community and curriculum advisers as to what Indigenous children need to learn
- develop teaching materials for lessons and be able to understand how best to use them with children
- take the lead in discussing teaching ideas and methods of programming lessons that encourage involvement of the community and other Indigenous teachers
- be a resource person who knows what community resources are available for use in the community’s education program
- be aware of certain things which would determine the best time, place and people for an activity and able to advise non-Indigenous teachers of local examples which illustrate ideas being taught
- be aware that some of the teaching and learning in science will include Western ways of understanding and experimenting.

Non-Indigenous teachers working in community schools

Non-Indigenous teachers often have the opportunity to teach in Indigenous communities and need to be aware of protocols when dealing with members of the community, Indigenous teachers and students.

- When seeking input from members of the community, teachers should ensure that they approach the right community member. This is particularly important when taking students on visits to community land.
- When seeking advice from Indigenous people, be prepared to listen rather than to ask questions.
- If you have an assistant teacher, involve them in the planning, programming and teaching; part of your role involves being a mentor. You can support the development of the assistant teacher’s role in the class.
There will be situations where Western and Indigenous aspects of a topic will be discussed in class. Work together with the assistant teacher or community people in a classroom discussion and avoid making judgements either way.

- Understand that you have a cultural background which differs from the Indigenous people of the community, and that they are attracted to aspects of your culture in the same way as you may be attracted to aspects of theirs.
- Indigenous students are willing to learn from you but may have different ways of learning and be more independent than non-Indigenous students.
- Indigenous students have many social responsibilities to their community, such as attendance at ceremonies, which may lead to them being absent from class.
- Social relationships between students may mean that they are unable to interact with particular students in the classroom.

Non-Indigenous teachers teaching in urban schools

a) Incorporating Indigenous perspectives in science

Science provides an opportunity to incorporate Indigenous perspectives. Topics may come up in the context of the classroom or community. It is recommended that you become aware of the Australian Indigenous Studies curriculum policy, and its knowledge and understanding outcomes.

- Promote understandings that Indigenous people might view the world in valid and different ways. Avoid making judgements when contrasting worldviews.
- Ensure that Indigenous perspectives lead to an understanding of Indigenous culture, without being superficial.
- Remember that knowledge production is socially based, that there is no one true way of understanding and explaining the world: explanations arise from culture.

b) Teaching Indigenous students in urban schools

In most urban schools in the NT there are students who identify themselves as being Indigenous Australians. Some of them have lived urbanised lifestyles for several generations whereas others may have recently moved into town only recently. These students as learners may display a range of understandings and attitudes to discipline.

- Indigenous students are often more independent learners and are used to cooperative ways of learning rather than competitive ones.
- Traditional ways of learning tend to be more passive for the Indigenous learner than in Western learning, and learners may be assessed on their competence in doing tasks rather than specific knowledge.
- Indigenous students have many social responsibilities to their community, such as attendance at ceremonies, which may lead to them being absent from class.
- Indigenous students may not have the facilities at home to do homework or research projects; their parents may not have experience of students doing these activities.
ICCAS Primary Science units
Teachers' Guide

SOLAR ENERGY
Teacher Notes
PRIMARY SCIENCE • Step 4

SCIENCE with FOOD
Teacher Notes
PRIMARY SCIENCE • Step 4

Adaptations of plants and animals
Teacher Notes
PRIMARY SCIENCE • Step 4

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The aim of this project has been to produce science units that are relevant to students in Indigenous schools and also extend the students’ scientific knowledge. The units of work have been written for teachers to use with primary students in Years 4, 5 and Upper Primary (Years 6 & 7). Some of the units will contain material and ideas that could be adapted for use with students at lower levels. There may be times when teachers will need to modify activities to suit the needs of their students.

The units of work are based on the information given in the following curriculum documents:

- NT Board of Studies. (1999). Science Learning Area Statement, including NT Outcomes Profile.

The ICCAS (Implementing the Common Curriculum in Aboriginal Schools) science units will require the use of commonly found materials rather than sophisticated scientific equipment (such as microscopes and bunsen burners) that is often not available in Indigenous schools. While some of these items can enhance a science program they are not absolutely necessary. A list of possible materials is given on page 44+, some of which could be purchased for your science program. References are also given with each unit.

WHAT IS IN EACH UNIT?

**Title page**
The title page tells what the unit is called.

**Credit page**
The credit page identifies the educators involved in the development of the unit.

**Unit planner**
The unit planner is divided into sections and includes:

- the topic
- learning outcomes: what the students will achieve
- sequence of lessons: names of lessons that the students will be doing
- references: books that were used for information to write the unit
- which strands and organisers from the outcomes profile will be covered.

**Teacher information**
Specific scientific information about the unit is detailed in the teacher information section. This gives the necessary background information about the topic. It will also explain the science concepts in detail that the students will learn while doing the unit.
The teaching/learning model
Working Scientifically is different to the other strands in that it is a ‘process strand’. This is an important strand because it details how to teach science.

As part of the process of making science more appropriate, the science teaching/learning model was designed for use in Indigenous schools and appears in the ICCAS science materials. Activities in the ICCAS science units are based on Working Scientifically through this teaching/learning model. There are six steps in the model. The model is flexible, as not all of the steps are used in every activity. Sometimes the steps are repeated. Sometimes the order will be different (see Figure 3 on page 8).

ESL strategies
In using the science teaching/learning model with Indigenous students, teachers need to incorporate English as a second language (ESL) strategies where appropriate in the learning sequence. A list of appropriate strategies is listed in the front of all Stage 5 and Upper Primary units and on page 23 of this handbook.

Activities
There are ten activities in each unit and each one contains ideas for approximately a one hour lesson (2 hours in upper primary). Teachers may adapt or modify these lessons to suit the needs of a specific class.

In the activity sections there will be some or all of the following:

<table>
<thead>
<tr>
<th><strong>key ideas</strong></th>
<th>the scientific concepts that will be taught</th>
</tr>
</thead>
</table>
| work requirements | what the students will do to achieve the learning outcomes and understand the key ideas  
The learning outcomes, which are in the unit planner, are the understandings about the topic that the students will have as a result of doing the unit. |
| teacher information | what needs to be organised before teaching the unit |
| materials | a list of the materials needed for an activity |
| time | a guide for how much time the lesson should take |
| student tasks | lessons written in sequence according to the teaching/learning model  
Modify the ideas to suit the group of students. |
| cultural considerations | ideas to consider to make lessons culturally appropriate  
It is important to consult with the appropriate Indigenous people from the community. These ideas are also suggestions and may require modification. |
| vocabulary | a list of words that relate to the activity  
Add more words to the list. The students will need to understand the meanings of the words to do the activity successfully. |
**further study ideas** | suggestions for extension activities
---|---
**worksheets** | for students to work on
**information sheets** | posters to give teachers and students information about the science concepts taught in the lesson to be referred to while teaching the lesson
**task cards** | specific instructions for doing one part of a lesson

**ASSESSMENT & EVALUATION**

**Assessment**
Assessment points are given at the end of each unit. Some of these are general points which will appear in all units and some are specific to the particular unit. They are all related to the work requirements listed with each activity. Teachers may wish to use the points in checklist form or to make anecdotal records and to collect samples of students’ work during the course of the unit.

When assessing, look for the following points:

- To demonstrate participation in class discussions the student will:
  - voice opinions
  - listen to contributions of others
  - show an understanding of the topic through oral contributions
  - use vocabulary that relates to the topic.

- To demonstrate participation in investigations the student will:
  - offer ideas for planning investigations
  - conduct investigations
  - record information from investigation appropriately.

- To demonstrate group work the student will:
  - work cooperatively with group members
  - value the contributions of other students
  - contribute ideas
  - listen to others.

**Students’ self-assessment**
There is a students’ self-assessment form included in the back of every unit. Students can complete it and give their thoughts about the unit of work. The form is a useful guide for evaluation. The completed form will also indicate what the students have learned and what they are interested in. Initially students will need support in filling in the form.
SAFETY

Safety issues are very important to consider when teaching science. This is particularly so if electrical equipment, fire and chemicals are being used. Teachers must provide a safe environment for students. The following pointers help to ensure safe science.

Make sure students
- follow instructions carefully
- use the equipment the way they should
- are careful when handling apparatus
- wipe up anything that is spilt straight away
- keep work areas organised, neat and tidy
- do not crowd around one place.

When using fire
- have a fire extinguisher nearby, or something to put out the fire if needed
- do not hold anything in the hand over a flame, use a peg or a holder.

When using electrical appliances
- make sure the equipment works
- do not let students fix any appliance that is broken
- do not put too many plugs in one power socket.

When using chemicals
- make sure containers are labelled clearly
- always check the labels on containers before using them
- do not put them in food containers or drink bottles
- lock away dangerous ones.

RESOURCES

There are many resources that can be collected for use in science. Some are junk materials found lying around, some are everyday items that can be bought at a small cost and others are expensive pieces of equipment. These units are designed so that teachers do not need to use expensive pieces of equipment. The following materials will be useful for schools to collect for their science program.

Books and videos
There are a large number of books available to use for teaching primary science. Check what is available in the school library, in storerooms and with other teachers.

On the Internet
Following are some sites available at the time of printing (December 1999):

http://sunsite.anu.edu.au/asta (the Australian Science Teachers Association)
http://abc.net.au/science (the ABC’s science homepage)
http://www.howstuffworks.com (all about how stuff works)
http://disney.go.com/DisneyTelevision/BillNye (Disney does science)
http://www.nasa.gov/kids.html (National Aeronautical and Space Administration kids’ page)
‘Junk’ materials
Some of these items may be readily available. Schools may organise to collect things and keep
them for later use.

bones
bottles, plastic and glass
bottle tops
buttons
clothes (to use as rags)
coat hangers
containers with lids
corks
cotton reels
egg cartons
feathers
garden tools
ice cream containers
jars
metals (assorted varieties and shapes)
milk cartons
newspapers and cardboard
pieces of fabric
plastic containers (all shapes and sizes)
plastic bags
polystyrene trays
rags for cleaning
rocks
shells
timber (assorted pieces)
toys (old and broken ones)
tins
tools (old ones not needed any more)
wheels (assorted shapes and sizes)

Inexpensive materials to buy
Some of these materials may be easy to get in communities. Most will be useful for science
programs. Some units require materials to be purchased.

aluminium foil
balloons
batteries
bicarbonate of soda
buckets
candles
cellophane
clothes pegs
cooking oil
cotton wool
detergent
food colouring
glue
matches
nails, screws
paints and brushes
paper and plastic cups
pegs (wooden spring)
pipe cleaners
plasticine
plastic spoons
pop-sticks
pots for growing seeds and
plants
rubber bands
salt
sandpaper
seeds (assorted)
sponges
sticky tape
sticky labels
straws
string
sugar
table tennis balls
tape measure
textas
toothpicks
vinegar
wood glue
Science equipment

This list is for those schools which have money to spend on specific science equipment. They are not essential items but would be useful to have.

- animal/insect cages
- aquarium and fittings
- barometer
- bike pump
- camera and film
- electric jug/kettle
- electrical wire
- filter paper
- funnels
- gas burner and bottle
- iron filings
- concave and convex lenses
- light globes
- magnets (assorted)
- magnifying glasses
- measuring cylinders
- medicine glasses
- multi purpose wire
- nets (pond and aquarium)
- nets (insect)
- petri dishes/plastic lids
- plastic tubing
- prisms
- pulleys
- sinkers
- solar cell kits
- spanners
- spring balances
- stethoscope
- stop watches
- test-tubes
- test-tube brushes
- thermometers
- torches
- trowels
- tweezers

Some of these items can be purchased from the following shops. Consult the NT telephone directory for contact information.

- Australian Geographic Shop in Darwin, or through their catalogue
- Big W Store in Darwin
- Dick Smith Electronics in Darwin
- K Mart Stores in Darwin or Alice Springs
- Medical and Laboratory Supplies in Darwin
- Medlab and First Aid Supplies (NT) in Darwin
- NT School Supplies in Darwin
- pet shops
- Tandy Electronics in Darwin, Alice Springs, Katherine and Nhulunbuy
INDIGENOUS KNOWLEDGE RESOURCES IN SCHOOLS

There is a diversity of resource materials available that focuses on Indigenous knowledge. Some of it is very general, whereas other material can be specific to one or two language groups. Many of the community education centres have literacy production centres associated with them that have produced useful resources, often in the local language but also in English.

General

Darwin/Top End

Tiwi

Kakadu
Arnhemland

Groote Eylandt

Katherine/VRD

Central Australia
Indigenous knowledge on the Internet
Following are some sites available at the time of printing (December 1999):

http://www.icat.org.au (the Centre for Appropriate Technology in Alice Springs, assisting Indigenous communities with suitable technology)
http://www.balkanu.com.au (Balkanu assists Cape York (QLD) Aboriginal communities work towards self reliance)
http://www.octa4.net.au/dhimurru (Dhimurru addresses natural and cultural management priorities for Yolngu land-owners in Northeast Arnhem Land)
http://www.natsiew.nexus.edu.au (culture and education of Aboriginal and Torres Strait Islander peoples)
http://members.aol.com/Afsci/africana.htm (academic papers on Africa’s indigenous knowledge systems)
http://www.ankn.uaf.edu (The Alaskan Native Knowledge Network)
http://windows.engin.umich.edu/sparc/ (then click on Cultural Connections in the menu bar for science from many cultures, available in three levels; beginner, intermediate, advanced)
http://www.si.edu/organiza/museums/amerind/nav.htm (National Museum of the American Indian)
http://www.nativeweb.org/ (resources for Indigenous cultures around the world)
http://www.fema.gov/kids/eqlegnd.htm (some legends about what makes the ground shake)
RESOURCES FOR STUDIES OF ASIA IN SCIENCE


RECSAM. (1994). *Science across Asia Pacific: Book 2.* Penang, Malaysia: Regional Centre for Education in Science and Mathematics. (Units: The impact of global warming, Renewable energy in Asia Pacific, Tropical forests, Domestic waste)

RECSAM. (1999). *Science across Asia Pacific: Book 3.* Penang, Malaysia: Regional Centre for Education in Science and Mathematics. (Units: Plants in our lives, Diseases, Acid rain, Disappearing wetlands).

The *Science across Asia Pacific* books are available through the Australian Science Teachers Association, PO Box 334, Deakin West ACT 2600. More information is available from their website, http://www.asta.edu.au


These two books are available from the Australian Association for Environmental Education Inc, PO Box 205. Manly NSW 1655. They are $15 each.