

# Engaging school communities with tropical science: a discussion paper for *School Science Engagement Across Capricornia (SSEAC)*

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## Background

### Inspiring Australian young people

The *Inspiring Australia: A National Strategy for Engagement with the Sciences* report was launched in February 2010 by the former Minister for Innovation, Industry, Science and Research (DIISR), Senator Kim Carr. It is a national strategy which aims to 'build a strong, open relationship between science and society, underpinned by effective communication of science and its benefits' through productive partnerships with government, agencies, organisations and communicators. It acknowledges the importance of developing a community of skilled and scientifically literate decision makers.

Among a range of recommendations, the report highlights the importance of 'raising awareness among young people of opportunities in science and research'.

Primary and secondary schools play a key role in promoting this agenda. Looming skill shortages in science, technology and engineering fields provide an economic imperative for investment in promoting science in schools. In addition, sustainable innovation can only occur in communities equipped to make evidence-based decisions about the application of new technologies to solve problems. Schools are the training ground for the development of the conceptual science understanding and critical evaluation skills for young Australians.

**Scientific literacy** comprises three dimensions: practical, civic and cultural. The practical component encompasses scientific knowledge to solve problems; the civic component refers to scientific knowledge and understanding needed to inform public debate and policy-making; and the cultural component refers to understanding about science as a human achievement. (Dillon, 2009; Shen, 1975)

## **Tropical Australia Expert Working Group**

The Inspiring Australia report particularly targets the science communication needs of traditionally under-served groups such as those living in regional and remote areas and Aboriginal and Torres Strait Islander communities. Recognising the distinctive context of the tropical regions of Australia, DIISR established an Expert Working Group focused on science engagement into and for the tropical regions of Australia.

The role of the Tropical Australia Expert Working Group is to develop an effective science engagement framework for Northern Australia that aligns with the Regional Development Australia (RDA) framework and the priorities of the Office of Northern Australia in consultation with key regional stakeholders. This Expert Working Group is chaired by Professor Peter Andrews, former Chief Scientist of Queensland and includes Professor Lyn Beazley, Chief Scientist of Western Australia and Professor Andrew Campbell, Charles Darwin University in the Northern Territory. It will convene for at least three meetings between December 2011 and February 2012.

The working group initially considered the issues related to science communication and engagement in the tropics across eight different scales. These scales were:

1. building science literacy for all tropical Australians
2. shifting science engagement cultures at the project and publication level
3. building durable and trusted regional science brokerage and partnership arrangements
4. effective science engagement in the Indigenous domain
5. building science partnerships at industry/sectoral level to turbo-charge innovation
6. building an integrated science and science management framework across tropical Australia
7. ensuring science messages from the tropics engage southern Australia
8. engaging tropical Australia in national science messages.

While effective promotion of tropical science to school students and teachers will ultimately benefit tropical Australia at all these scales, effective school engagement fits most appropriately at the individual scale of building science literacy for all Northern Australians. Furthermore, case studies indicate that effective science engagement with schools can have a multiplier effect—often it is not just students and teachers that are engaged but also a significant proportion of the wider community (Tytler, 2008).

For example, in the Burdekin Region in the Queensland Dry Topics research identified that the third most important source of information for landholders to base their on-farm decision-making, originates from school education (Greiner et al., 2003). The most important source of information for NRM decisions were family members followed by financial advisors.

There are a number of challenges in engaging tropical Australian schools with science and scientists—particularly rural and remote schools (Lyons et al., 2006). These challenges include:

- high annual staff turnover rates
- relative lack of experience in teachers

The three key and inter-related features required for effective science engagement with schools in Northern Australia are:

1. Engaging students with science that is locally relevant and meaningful
2. Building partnerships between schools, organisations and industry
3. Funding staff to facilitate and coordinate school tropical science engagement

## **1. Engaging students with science that is locally relevant and meaningful**

In reviewing the value of locally relevant school-community linked projects to student learning, Tytler (2007) recommended that ‘school science should be linked more often and more closely with local and wider communities, and science should be studied in community settings that represent contemporary science practices and concerns. Ways need to be found to embed school–community initiatives into the curriculum in sustainable ways.’

Much of the curriculum taught in Northern Australian schools is written in Southern Australia. Real-world and current science applications—if used at all—tend to showcase research conducted in Southern Australia. This science is usually outside the experience of students in Northern schools. Where tropical schools have the opportunity to forge relationships with scientists, students are highly engaged. For example, students from Tagai College in Torres Strait conduct Seagrass Watch programs in partnership with government departments, institutions and agencies. Through these programs, students develop a scientific understanding of their surrounding marine environment and the impacts that humans have on seagrass communities within the context of traditional practices.

Science Education Centres in regional areas play a significant role in promoting tropical science to students. The CSIRO administers two centres, one in Darwin and one in Townsville which provide an important link between schools and Northern Australian science.

The Townsville-based Education Centre has provided innovative and engaging science programs to schools throughout North Queensland since its inception on 1993 and is supported by Education Queensland, Queensland Nickel and James Cook University.

The Darwin Education Centre is the hub for CSIRO’s science education programs in the Northern Territory and is a partnership with the Northern Territory Department of Employment, Education and Training. It hosts the Cutting Edge Lectures Series of forums for teachers and senior students by leading scientists in current topical fields of science.

CSIRO Education offers teacher professional development and a range of curriculum lined hands-on science programs from Prep - Year 12. These sessions are available as excursions to the centre laboratory or as Lab on Legs visits to school classrooms. Teams travel to local, regional and remote schools around Northern Territory and within North Queensland extending as far north as the Torres Strait, as far south as Mackay and as far west as Mt Isa.

For additional information about CSIRO Education, North Queensland go to [www.csiro.au/Portals/Education/Teachers/Incursions-and-excursions/education-centres/Education-NQLD](http://www.csiro.au/Portals/Education/Teachers/Incursions-and-excursions/education-centres/Education-NQLD)

For additional information about CSIRO Education, Northern Territory go to [www.csiro.au/darcsirosec](http://www.csiro.au/darcsirosec)

## **Integrating local ecological knowledge and scientific knowledge**

Other Northern Australian agencies such as Natural Resource Management (NRM) regional groups and industry partnership programs have proved highly successful in sharing locally relevant science and integrating local community and scientific knowledge. In the Ingham district, primary students monitored water quality in their local creek as part of a larger multi-industry program coordinated by Terrain NRM staff to advise farmers, graziers and fishers about sustainable farming practices for maintaining water quality.

## **Online resources**

Excellent online curriculum resources tailored for a Northern Australia context already exist. For instance, the *Burning Issues* online learning module focuses on the need for well-informed decisions about planning and fire management to ensure lives are protected and healthy ecosystems and biodiversity are conserved in the tropical savannas—one of the most fire-prone of the world's major biomes. It highlights the need for a collaborative approach involving traditional Aboriginal landowners, volunteers, council members, regional bush fires committees and researchers to help protect life, property and the environment in northern Australia from the effects of wildfire and ensure a sustainable future for all.

Using these resources students will be able to explore some of the key issues of burning for land management in northern Australia in order to develop an effective public awareness campaign for a target audience that includes some scientific evidence to support their key messages.

The national implementation of the Australian Curriculum will make it easier to generate locally relevant curriculum materials across the Northern areas of Western Australia, Northern Territory and Queensland. Curriculum resources aligned to the Australian Curriculum will be promoted via Curriculum Connect, an online portal administered by Education Services Australia. Indeed, this portal will also provide an opportunity for educators in Northern Australia to promote teaching resources about cutting-edge tropical science to teachers in Southern Australia.

However, many teachers—particularly those new to regional areas—do not know that locally relevant online resources are available. Teachers are time-poor and under increasing pressure to justify accountability and performance requirements. A high proportion of teachers in regional areas teach multi-age classes with special language and learning support needs. These teachers have little discretionary time to plan units of work and to seek out resources relevant to their students' needs. Addressing students' needs is an essential aspect of engaging school communities with tropical science in northern Australia. Schools in northern Australia are characterised by a significantly higher proportion of Indigenous students compared with their southern counterparts (see Appendix 2 for more details).

## **Pre-service teacher education**

Pre-service teachers are another key audience for curriculum resources tailored to tropical Australian needs. Survey data indicates that pre-service teachers who are trained in regional

areas tend to teach in those same regional areas when they qualify (Hackling et al., 2000). Investment in programs which engage pre-service teachers with tropical science topics and networks will have a flow-on effect in the classrooms of the future.

In addition, partnerships with teacher training institutions can ensure that pre-service teachers are exposed to current tropical science. In fact, pre-service teachers can work with agencies to generate curriculum materials for use in schools. JCU pre-service teachers were involved in a community-linked project to promote understanding about the Cattana Wetlands in Cairns. Students researched the wetlands and prepared interpretive information, online resources and signage for use by local schools and community members.

In this paper, the term 'science' describes research science, applied science, technology and

## Indigenous junior ranger programs

In remote areas, Indigenous junior ranger programs are highly effective in promoting science to students in remote communities for meaningful learning through the context of local issues that link Western science and Indigenous Knowledge. Recent research has identified the intergenerational transmission of Indigenous Knowledge (IK) and the role experiential learning on Country plays in the transmission of Western scientific knowledge and IK between scientists and Indigenous people involved in such programs (Fogarty, 2010).

For example, the establishment of a Wildlife Enterprise Program in Maningrida in Arnhem Land emphasised the importance of links between education and training and the knowledge needed to run the wildlife enterprise, all of which depended on the important contribution of both IK and Western scientific knowledge (Fogarty, 2010). Junior ranger programs provide opportunities to 'learn through country' which integrate and link Indigenous Knowledge and cultural practices with science in a meaningful context. Other benefits of such programs include establishing pathways for post-compulsory employment and training and providing community members (including Indigenous and scientific) with opportunities to be vocational and cultural role-models for students.

However, while successful examples of Indigenous junior ranger programs are evident in remote communities, with some (e.g. Kakadu Junior Ranger Program) forming an integral part of school education, they are widespread geographically but not prolific throughout northern Australia. Fogarty (2010) contests that past and current educational practices have failed to link three critical components necessary for educational relevance and successful outcomes in remote Indigenous contexts. These critical components are:

- the educational demands of the local labour market
- the recognition of Indigenous knowledge and development aspirations
- the role of localised pedagogy to create purposeful and relevant learning.

Recent research, however, has shown that securing funding to establish and then sustaining such programs is problematic despite the success of such programs. Despite these barriers, these programs are viewed by their respective community as important to both the future of land and sea management programs and the engagement of Indigenous youth.

Subsequently, in order to engage students with science that is locally relevant and meaningful, by integrating ecological knowledge and scientific knowledge through culturally responsive NRM and Junior Ranger Programs, partnerships need to be built between

schools, organisations and industry, Further, funding needs to be forthcoming to fund the key resource—people (Schwab, 2006).

## **2. Building partnerships between schools, organisations and industry**

### **Existing partnerships**

The case studies outlined in Appendix 1 are a small sample of the many existing fruitful partnerships that exist between science-based agencies, industry and schools. A school science engagement facilitator can build on those existing projects and also gather case studies and transferrable knowledge about how similar projects can be effectively managed. Much can be learned from evaluation reports on previous programs such as the ASISTM program about how a Northern Australian school-science engagement program could be efficiently structured.

The Australian Science Teachers' Association, state-based Science Teacher Associations and other relevant professional associations are valuable partners with a history of support for similar programs which could target Northern Australia. These organisations are invaluable for making connections in the wider state and national context. However, these organisations are largely self-funded and would require additional funding to actively cater for the special needs of a Northern Australian program.

One advantage that a Northern Australian approach to school-science engagement provides is the development of an effective network of stakeholders across the region. Regular face-to-face conferences have been shown to greatly enhance the efficacy of regional networks and also to raise the profile of the program outcomes.

There are a number of institutional barriers to be overcome. For instance, scientists in research organisations generally receive little or no recognition for the excellent school and community engagement work that they do. With the result that passionate scientists tend to conduct their community engagement activities 'in their own time'. Given the value of positive stakeholder engagement to agencies, scientists should receive some acknowledgment and allocated time for the community and school engagement activities they are involved in.

Similarly, the design of new science research programs in Northern Australia should include an explicit school and community education and engagement component which seamlessly integrates with program goals and timelines. The *Burning Issues* online resources provide an excellent example of how cutting edge research can be packaged and communicated to schools and the general public in a highly engaging way. Translating the science into school and community education products also provides a legacy that can last well beyond the life of the program.

### **Co-funded programs**

There is also the option of co-funding of targeted projects by agencies or industry. Teachers are increasingly time-poor and less inclined to develop their curriculum resources from scratch. If a Northern Australian agency or industry wants to promote its science and key

messages into schools, it needs to provide some base curriculum resources on the topic which teachers can then adapt for their classrooms.

Input from industry in the development of curriculum resources will not only ensure their relevance but ensure that students are developing industry standard skills that will provide them with a platform for pursuing a career in science. School-based vocational training is also an important mechanism for building linkages between schools and industry. The completion of VET qualifications such as the Certificate II in Sampling and Measurement (MSL 20109) start students on a vocational training pathway that opens up a range of accredited training options depending on local industry needs. The option of a School Based Traineeship in Laboratory Operations can not only start students on a vocational pathway but serve as a school retention strategy and assist in keeping students engaged in learning through to the completion of Year 12.

Career Development Programs and Work Placement can all be linked to existing curriculum to form an industry context for learning and engagement. This in turn exposes students to career opportunities in Science and Engineering from a local context that they can relate to.

### **3. Funding staff to facilitate and coordinate school tropical science engagement**

As the case studies demonstrate, science engagement projects work most effectively in schools when they are coordinated by a facilitator who is not a full-time classroom teacher or educator. In evaluating the national Australian School Innovation in Science, Technology and Mathematics (ASISTM) Project, Tytler et al. (2008) noted that the “consensus amongst the study team is that there are significant benefits arising from a separation of educational leadership and project management and that the funding of projects should recognise this”.

The ASISTM Project funded 74 innovative science, mathematics and technology partnership projects in schools nationally—with some outstanding results. Some of the projects were conducted in Northern Australia. The Science on the Oval (SOTO) project was an existing event held on the Whitfield State School oval in partnership with the School of Education at James Cook University (Cairns). Pre-service teachers from JCU conduct engaging hands-on science activities for thousands of primary and secondary school students including significant numbers of Indigenous students. The injection of ASISTM Project funding enabled the event to be taken ‘on the road’ to regional schools and also produced a curriculum resource of hands-on science activities suitable for outdoor use.

This project has been sustained because it is organised by a committee comprising teachers, pre-service teacher educators and additional staff with funded capacity to assist with the project management and general organisation.

#### **Funding cycles**

There are many examples now that show how injecting relatively small level of funds for school-community partnerships can have spectacular results. The ASISTM projects were generally funded for less than two years and delivered effective science, mathematics and technology outcomes. However, many of these projects proved unsustainable in the longer term unless they were ‘built upon existing alliances or communities of interest’ (Tytler et al., 2008).

In the last decade, Education Queensland funded regional project officers in two separate science education programs (Spotlight on Science program and the Science Education Strategy) who effectively brokered partnerships between schools, agencies, institutions and industry. However, the three year funding cycle for both these programs meant that many projects which were just starting to bear fruit did not continue when the funding ceased. In contrast, SciTech in Western Australia is funded partly by industry has a history of developing and maintaining longer term productive partnerships.

To be effective, funding for staff to facilitate science engagement partnerships and activities in schools should preferably extend at least five years to build on existing communities of interest and effect change.

#### **Facilitation role**

To be effective in promoting tropical science to Northern Australian schools, a science engagement facilitator would need to be based in the region in which they are working. It is

important to develop workable face-to-face relationships with staff from partner organisations and industries. They need to have both teaching and project management experience and be committed to goal of achieving successful outcomes for the program. The job description would need to be flexible enough to enable the facilitator to take advantage of opportunities to develop innovative approaches relevant to their region.

Their role of a regional school tropical science engagement facilitator would be to:

- identify and grow linkages with partner organisations and industries
- manage targeted curriculum resource development about tropical science
- organise teacher professional development which trains teachers in effective practices and showcases existing curriculum resources
- liaise with stakeholders in their region and with counterparts in other states to share ideas and resources.

Additional funding is required to support other targeted programs in Northern Australia such as CSIROSEC and the Scientists in Schools program.

### **Recommendations**

To build an inspiring tropical sciences school engagement program, the authors recommend **funding** to support establishing a community of interest to effect science engagement systemically in schools across Northern Australia by:

- extending longer-term funding for existing science-school programs that target North Australian outreach
- appointing regionally-based facilitators to build cross-agency-industry networks and identify opportunities and implement projects
- convening twice-yearly face-to-face symposia for stakeholders to share ideas and resources, to build a community of interest and identify opportunities to effect and sustain change
- creating local relevant and meaningful curriculum resources based on tropical science which are culturally responsive and exemplify good teaching and learning practices
- developing an online resource portal to capture and promote tropical science education aligned to the Australian Curriculum
- supporting the inclusion of cutting edge tropical science in pre-service and in-service teacher professional development
- supporting a systemic Indigenous junior ranger program across Northern Australia
- building partnerships between interested professional organisations in Northern Australia

- advocating recognition for the scientists and researchers who actively promote and communicate their tropical research and ‘science as a human endeavour’ to the community
- advocating the inclusion of a school and community education component in all northern Australian research projects
- exploring opportunities for co-funded programs in Northern Australia.

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## Appendix 1

### Engaging school communities with tropical science—case studies

#### Smithfield State High School biochar project (Cairns, Queensland)

A collaborative action research project between Smithfield State High Science Department and the School of Education and the Faculty of Science and Engineering at James Cook University (JCU-Cairns) resulted in significant improvement in Year 9 student achievement in Science and a high level of student engagement with science.

With the help of a JCU PhD student, Amy Beavan, students conducted authentic research trials on the effects of biochar on plant growth. Biochar is charcoal and is formed by burning carbon containing material such as bagasse or wood in limited oxygen at high temperatures. Burning the materials in this way locks the carbon atoms into the charcoal structure for hundreds of years, rather than releasing it into the atmosphere as carbon dioxide greenhouse gas, as would be the case if the material was burnt in oxygen or allowed to decompose.

Biochar has also been found to have a beneficial effect on plant growth if mixed into soil. Students investigated the effect on plant growth of adding different amounts of biochar to soil.

Staff from the School of Education at JCU assisted in the design of an effective teaching and learning cycle to enhance the student conceptual understanding, skills acquisition and engagement. The project was also evaluated and presented at the 2010 Science, Technology, Engineering and Mathematics Conference in Brisbane.

#### ***What's in the Water?: A Herbert River water quality project (Ingham, Queensland)***

In the Herbert River catchment, primary students, working with local scientists and industry partners, monitored water quality parameters (both abiotic and biotic) in their local waterways and contributed data to inform land management decisions that will affect the Great Barrier Reef.

The Herbert River catchment is located on the coast north of Townsville around Ingham. It is a rural, agricultural area whose industries include sugar cane, cattle, fishing and tourism. It is surrounded by two World Heritage Areas: the Wet Tropics World Heritage Area and the Great Barrier Reef Marine Park.

Sediment and nutrients from catchment run-off harm the health of the Great Barrier Reef. In this innovative catchment-wide project, staff from Education Queensland's Science Spark program trained teachers and student leaders in water quality monitoring techniques for local waterways, utilising expert technical advice from staff at the Terrain Natural Resource Management (NRM) regional group and the Reef Guardian Schools (Great Barrier Reef Marine Park Authority) program trained teachers and student leaders in water quality monitoring techniques for local waterways—maintaining a careful watch for local crocodiles. The students shared their scientific understanding about the significance of water quality

issues in Great Barrier Reef catchments with other students and their communities, via electronic means such as web conferencing, virtual classrooms and a community NRM Forum.

Other partners in this water quality project were James Cook University, Hinchinbrook Shire and Tablelands Regional Councils, Department of Environment and Resource Management, Department of Employment, Economic Development and Innovation, Sugar Research and Development Corporation and involves stakeholders from the forestry, mixed cropping, grazing and sugar industries. Parents were also involved in the water sampling activities. The project was part of a long-term program (Herbert Water Quality Monitoring Project—HWQMP) coordinated by Terrain staff who established a multi-industry taskforce to advise farmers, graziers and fishers about sustainable farming practices for maintaining water quality.

The school project model was based on a previous trial conducted in 2010 with twelve small schools in the Ingham district. The 2010 project was based on a biodiversity theme and was supported by the Queensland Museum's *Backyard Explorer* program. The 2010 project resulted in the development and recording of the delivery model now known as the *Earth Smarties* model.

For the *What's in the Water?* project, teachers developed a unit of classroom work based on a water quality and conservation theme. Using a 'kids teaching kids' approach, participating schools nominated student leaders with a particular interest in the environment who were trained to use water quality testing equipment. In turn, these students trained other students in their school. Face-to-face training sessions were followed up by online training. High school students acted as mentors for the younger students.

The schools compared data from twelve selected sites across the Herbert River Catchment and made recommendations to local management bodies.

The school involvement was supported by staff working with a number of Education Queensland programs—the Science Spark program, the Earth Smart Science Schools program based at Paluma Environmental Education and the Clever Networks program. Participating schools received training on how to use data loggers with a range of water quality sensors to be used for this and subsequent projects.

The *Science Spark* program provided science professional development for teachers of Years 4 to 7. The *Earth Smart Science School* program assisted schools to plan and implement their School Environmental Management Plans to enhance their sustainable practices. Both of these are funded by Education Queensland to support primary teachers in Queensland state schools from 2010-2012. The Clever Networks program aims to expand the range of Information and Communication technologies (ICTs) in schools.

The Herbert River water quality project was highly successful. Students were very engaged by the opportunity to work closely with scientists, to contribute to a real-world scientific research project and to make a difference in their local environment. It raised the awareness of teachers, students and parents about the ecosystem health issues in their catchment.

The students—and teachers—gained a solid understanding of the indicators of water quality, how catchment water quality affects coastal water quality, and some strategies for improving and maintaining that quality. In addition to the environmental citizenship and scientific skills gained, students used a range of ICT applications such as wikis and blogs to share information and ideas. A virtual classroom on the Education Queensland online portal, the Learning Place, was used to store information and teacher support documents, communicate findings and share the digital story presentations about their activities.

The project provided additional social benefits for both students and teachers. Many small schools have only one or two students in a year level cohort. The project provided an opportunity to interact with students of similar age from other schools and also with high schools students who acted as mentors for this project. The development of these relationships will be valuable for the young students as they transition from primary to secondary school.

Similarly, in schools with only one or two teachers, there are limited opportunities to interact with other teachers. This project allowed teachers to plan and teach collaboratively, using both face-to-face and electronic approaches.

The *What's in the Water?* project provided students with a great opportunity to participate in a real-world science project using cutting edge technology that will potentially make a difference to the environmental values of their catchment and the Great Barrier Reef.

## **Torres Strait Land & Sea Discovery Centre (Thursday Island, Queensland)**

Established in 2011, the Torres Strait Land & Sea Discovery Centre is a multi-use facility that provides educational experiences and training for students and the community. It is the culmination of a long-term and productive partnership between Tagai College, the Torres Strait Regional Authority and the Australian Government. Andrew Denzin co-ordinates the centre and its ongoing partnership activities including Seagrass Watch, Clean Up Australia Day, Reef Guardians and numerous other initiatives

The Torres Strait Land & Sea Discovery Centre includes a 'touch tank' with a wide variety of marine organisms and interactive displays that showcase both traditional Torres Strait ecological knowledge and marine science. The facility also caters for community engagement activities, tourist visits and scientific research.

For more information, go to

<[www.tsra.gov.au/land--sea-management-home/news--events.aspx](http://www.tsra.gov.au/land--sea-management-home/news--events.aspx)>

## **Maningrida field projects (Northern Territory)**

An innovative senior school science program in Arnhem Land that values Indigenous Knowledge and blends it with western science is producing outstanding results not just for the students but also for the community.

At Maningrida Community Education Centre (CEC), 2007 Eureka Prize winning science teacher Mason Scholes recognises that Indigenous students have a deep understanding of their country and validates this by developing a relevant science-based career pathway that students can pursue in their own community. Since his science program began in Maningrida, Mason and his students have identified at least 45 new species of spider.

The students are enthusiastically engaged in a range of field projects with the Djelk Rangers who manage and monitor the recently declared Djelk Indigenous Protected Area (IPA) in central Northern Arnhem Land. The Djelk Rangers work with a range of partners on a number of projects that control invasive species, maintain historical fire regimes, monitor marine resources and prevent pests entering Australia.

One of the field projects involves collecting local spiders in partnership with Dr Robert Raven from the Queensland Museum. Since Mason's program began three years ago, students have discovered at least 45 new species of spiders that he is currently classifying.

Apart from identifying new spider species, students working with the Djelk Rangers on a range of other projects including the collection and incubation of crocodile and turtle eggs, commercial hunting of crocodiles, buffalo disease monitoring, foreign fishing vessel issues, mining and *Mimosa pigra* control.

Not only are students engaged and motivated on country, they conduct scientific research. For instance, one Year 12 student developed a successful 'pied-piper' technique for collecting spiders by using the vibrations of a diesel car's idling engine to attract spiders. His enterprising approach proved to be a far more effective method for collecting spiders with 57 spiders collected when the car was idling compared with only seven when the engine was switched off.

Engaging the community, especially the Maningrida Djelk Rangers Wildlife Officers, has inspired the students. Students gain a first-hand understanding of the Rangers' work and are encouraged to seek similar employment. Graduates from the program are employed in the community.

Maningrida CEC together with Robert Raven is now part of the CSIRO's Scientists in Schools program in the Northern Territory. Students are currently studying what could be the largest population of tarantulas in the world. The students are in the process of setting up a new enterprise to breed the tarantulas to sell, a project from which the entire community will benefit. 'As the partnership progresses, more of these Indigenous students are opening their eyes to the possibility of a career in science all through the support of a scientist and the belief of a teacher.'

For more information about this project, go to  
<[www.bawinanga.com.au/djelkrangers/index.htm](http://www.bawinanga.com.au/djelkrangers/index.htm)>  
<[www.scientistsinschools.edu.au/showcase/scholes-raven.html](http://www.scientistsinschools.edu.au/showcase/scholes-raven.html)>

## **The 'Science on the Oval' SOTO project (Cairns, Queensland)**

A SOTO (Science on the Oval) Day is held at Whitfield State School and the SOTO Roadshow is held at a different state school each year. Thousands of primary and secondary school students including significant numbers of indigenous students experience exciting hands-on science activities designed by pre-service teachers from James Cook University (Cairns). The project provides an innovative research framework for teacher education and sustainable partnerships in promoting science education and in doing so has become a signature event.

The SOTO Project is funded by the Whitfield State School with additional funding in 2006 and 2007 from the Australian Government's *Australian Schools Innovation in Science, Technology and Mathematics (ASISTM)* Project to take SOTO to regional schools.

Since the first event in 2003, SOTO has provided premium science learning experiences to over 6000 primary and secondary students including an estimated 1,000 indigenous students and attracted positive media coverage on science teaching and learning in our Far North Queensland schools. Through its success in the ASISTM Project, SOTO now has also a national profile; showcasing exciting science learning opportunities provided by Far North

Queensland schools. In addition, the event has been very successful in engaging the wider school communities and parents.

## **Certificate II in Sampling and Measurement (MSL20109)**

The Gateway Schools Project for Manufacturing and Engineering works with schools across Queensland to assist in the implementation of the Certificate II in Sampling and Measurement. The completion of this qualification will provide students with hands on and practical industry standard testing skills which can lead them into testing career pathways including: food processing, manufacturing, soil, water, mining, construction and agriculture fields.

As part of this project teachers from Innisfail State College, Bowen State High School, Good Shepherd Catholic College (Mt Isa), Northern Beaches State High School (Townsville region), Capricornia School of Distance Education, Mossman State High School, Dysart State High School, Kirwan State High School, Charters Towers State High School are undertaking training in a Certificate III in Laboratory Operations (MSL30109). This qualification will give teachers the knowledge and industry standard skills to implement this VET certificate in their schools. To date, this training for teachers has been funded by the Productivity Places Program.

Part of the implementation of this qualification will see schools aligning closely with local industries who undertake scientific testing. This alignment will allow students to see a wide range of career pathways available to them, complete work placement and potentially transition into school-based traineeships in Laboratory Operations. Students would then have the opportunity to continue further VET training qualifications or explore university pathways.

In order to support teachers in this program, Manufacturing Skills Queensland (MSQ) and the Manufacturing and Engineering Gateway Schools Program has developed a range of VET templates that allow schools to include a local context in their training, as well as a range of professional development workshops that include teaching resources that can be adapted to local industry contexts.

This project encourages schools to develop strong local industry links that can be expanded and enriched over time.

## **Scitech's programs in the Kimberley region of Western Australia**

Scitech is Western Australia's leading science educational and engaging science centre located in Perth. As a not-for-profit organisation, funding for the centre comes mostly from government grants, corporate partnerships and admission and membership fees. Scitech runs an extensive outreach program including targeted programs in Northern Western Australia.

### **Aboriginal Education Program**

The Aboriginal Education Program (AEP) aims to reach all parts of Western Australia more frequently with more culturally relevant and appropriate science programs for Aboriginal students and their teachers, and to actively involve the wider community. Scitech's AEP visits every remote Aboriginal school in Western Australia every two years, spending between one and three days at each school.

The AEP is a comprehensive education program, and in addition to its incursion component, Scitech also provides ongoing support and educational resources for teachers, all of which have been specifically developed to suit the learning needs of Aboriginal students, and to address the difficulties of teaching in remote locations.

A primary aim of the program has been and continues to be the delivery of a program which is culturally relevant. The Scitech team have consulted and collaborated with a number of Aboriginal education experts as well as with local communities to ensure the program content is appropriate, contemporary and relevant. They developed activities that cater to the learning styles and needs of Aboriginal students. In addition, all Scitech staff involved in this program receive cultural competency training.

The student workshops and teacher resources are tightly linked to the primary science curriculum, and have a strong literacy focus. The workshops are designed to be engaging for the students, and demonstrate to teachers and Aboriginal Islander Education Officers that engaging hands-on activities don't have to be complicated to run. They consist of short, sharp hands-on science activities which are flexible and fun.

In 2008, findings of a pilot study by the Centre of Indigenous Australian Knowledge at Edith Cowan University into the effectiveness of the Scitech Aboriginal Education Program suggested that:

1. After participation in Scitech's professional learning sessions, teachers show increased confidence for teaching science.
2. The Scitech AEP encourages student attendance and increases student motivation to engage in science.

A more comprehensive study was conducted by the same team in June 2011, and the findings will be available in March 2012.

In 2010-11 the Scitech AEP program visited 42 towns and communities across all WA, reaching a total of 4,179 people.

Due to the high cost of face to face presentation Scitech provides 5 DIY specific science kits for remote schools for teacher lead activities. In 2010-11 these kits were loaned out 15 times and reached 528 students and 22 teachers. The kits are a valuable resource for remote teachers as they provide all the information and resources for a term of science.

### **Outreach Programs in the Kimberley**

Scitech's Outreach team visits all of the towns of the Kimberley region every year with one of the following programs: Maths, Science, Astronomy, Technology, or Early Childhood. The team also has a presence in the Kimberley with their interactive exhibits at community events throughout the year, such as the Ord Valley Muster in Kununurra. The Outreach team provide services on demand to School-of-the-Air programs in the Kimberley. This is a valuable service for remote families as the program is supported by sending out experiment kits before the radio session.

### **Inspiring Australia WA Strategy**

Scitech has held a community consultation session with science interested people and organisations in Broome with the objective of developing a local science co-ordinating committee that can run local science engagement initiatives.

### **'International Year of...'**

In 2009 Scitech conducted WA's Year of Astronomy and in 2011 we co-ordinated the Year of Chemistry that involved state wide tours that included the Kimberley for community based events.

Scitech's host of science engagement programs could readily be translated across into the NT and QLD, the AEP being particularly relevant to Aboriginal students in these states, being both culturally and geographically appropriate.

## **CSIRO Education centres in northern Australia**

The CSIRO Education centres based in Townsville and Darwin are part of a network of nine CSIRO Education centres nationally with the Townsville centre being the only one outside a capital city. The centres aim to excite and educate students, teachers and the wider community through hands-on science experiments and workshops showcasing the vital role of science and technology in Australia.

Together, both centres can access up to 16,000 school students each year with their curriculum based science programs. In total, there are over 25,000 yearly participants in the centres' programs through Double Helix Science Club and holiday science events and library and vacation care activities.

CSIRO Education Northern Territory is a joint initiative between CSIRO and the Northern Territory Department of Education and Training. CSIRO Education North Queensland is a joint initiative of CSIRO, James Cook University Queensland, Department of Education and Training and Queensland Nickel. These valuable long standing partnerships have allowed the centres to continue operations for significant time periods (CSIRO Education Northern Territory since 1990, CSIRO Education North Queensland since 1993) and have provided much needed stability in the science education sector.

School groups visit the centre laboratories or receive individual school visits from experienced presenters. Centre staff also run over seven Lab on Legs tours to regional and remote areas during the year. Staff from the Darwin-based centre may travel to remote areas such as Batchelor, Jabiru, Nganmarriyanga and Yirrkala homeland schools, Katherine, Alice Springs and Nhulunbuy with their programs. The Townsville-based centre may travel to regional areas such as Cairns, Cooktown, Atherton Tablelands, Innisfail, Palm Island, Bowen, Mackay, Hughenden, Richmond and Mt Isa.

Lab on Legs tours to regional and remote areas is highly dependent on access to travel funds as the centres need to operate on a cost recovery basis. While this funding can come from school grants or from external partnerships such as industry and universities, travel to remote and regional indigenous schools and communities is often not possible due to lack of funds.

The CSIRO Education centres also run numerous teacher in-service sessions and are currently training teachers in how to successfully introduce CSIRO's CarbonKids program into their schools. CarbonKids is a new, innovative school-based program that combines the latest science with sustainability education and action.

Scientists in Schools, which includes the sub-program Mathematicians in Schools, is a national CSIRO program that creates and supports long-term partnerships between teachers and scientists or mathematicians. The CSIRO Education centres based in Darwin and Townsville are each the home base for a 'Scientists in Schools' project officer who promote the program to teachers and scientists locally as well as matching and support partnerships.

At the end of 2011, there were 35 active partnerships in the Northern Territory and 99 active partnerships in North Queensland. One such partnership between the Maningrida

Community Education Centre, NT and the Queensland Museum has resulted in students discovering a tarantula species unique to the Northern Territory and establishing a breeding program that will benefit the entire community (see *Maningrida field projects* above).

Scientists in Schools is funded by the Australian Government Department of Education, Employment and Workplace Relations and CSIRO. The current funding agreement ends 30 June 2012.

## **Reef Guardians – Working together today for a healthier Reef tomorrow**

Reef Guardians, an initiative of the Great Barrier Reef Marine Park Authority (GBRMPA), is a voluntary stewardship program made up of schools, councils, fishers, graziers and farmers and is proving that by working together today we can all contribute to a healthier Reef for tomorrow. The Reef Guardian program empowers communities to help build the resilience of the Reef in the face of threats including changing climate.

The Reef Guardians program was launched in schools in 2003 as a behaviour change vehicle to encourage the community to take action for a healthier Reef. The Schools program works across five key areas of engaging schools in: curriculum, on-ground projects, resource management, building supportive partnerships and promoting their Reef Guardian activities and learning. In 2012, there are over 280 Reef Guardian Schools and over 110,000 students engaged through the program across Queensland. Due to the success of the Schools program, the Reef Guardians program expanded to councils in 2007 and to farmers, graziers and fishers in 2011.

The Reef Guardian Schools Future Leaders Eco Challenge (FLEC) is held annually across Queensland to involve students in hands-on, field based activities in their local ecosystems that are translatable to school environmental projects and learning. The FLECs also provided teachers with a professional development opportunity. The 2011 FLEC themed Working together today for a healthier Reef tomorrow, aimed to help students connect sustainability and environmental initiatives within their community to a healthier Great Barrier Reef.

Seventeen FLECs were held across Queensland during term 3, 2011 with over 105 schools, 750 students and 150 teachers participating in hands-on science investigations that related to local environmental issues. Eighty partners, including natural resource management organisations, councils and industry representatives were involved in facilitating locally relevant activities at the FLECs that aligned with key natural resource management for the region.

There were many diverse activities that students and teachers participated in including soil testing, water quality monitoring, biodiversity assessments, waste management and protecting wetlands from invasive species. Year 4-7 students from Bwngcolman Community School and St Michaels Catholic School, Palm Island participated in seagrass monitoring and water quality monitoring training at their FLEC. The resources for these monitoring programs were given to the schools after their FLEC to provide an opportunity for long term student involvement in monitoring and learning at locations that are significant to the students (local beach and waterways) and link with the Australian Curriculum.

In November 2011, the Great Barrier Reef Marine Park Authority science teaching units were launched and distributed to Reef Guardian Schools to assist them to connect curriculum with the other four, key areas of the program. The science units are from year one – year ten with early year activities (foundation year – year two) and senior year

investigations (year 11 and 12) also available. The units were developed on the GBRMPA focus areas identified in the Great Barrier Reef Outlook Report 2009 and link with the new Australian Science Curriculum and Curriculum in the Classroom. The GBRMPA Teaching Units are in draft (current Version 0.1) similarly to the Australian Curriculum and will be modified in the near future to align with new information on the Australian Curriculum as it becomes available. Reef Guardian Schools across Queensland are currently trialling the units in 2012.

The Reef Guardian Schools program engages students and teachers in relevant sustainability and education for the Tropical North and supports students being active stewards of the environment from foundation year through to year 12 and beyond in their community.

## **Queensland Museum's Backyard Explorer—North Queensland**

How do you assess the biodiversity of your local area and measure the impact that human activities may have on your ecosystems? In 2010 and 2011, Queensland Museum scientists conducted Backyard Explorer insect trapping workshops to answer these questions.

Students, teachers, traditional owners, Landcare groups, natural resource management staff and community members participated in these hands-on workshops held in North Queensland centres as far afield as the Torres Strait Islands, Rockhampton (North Keppel Island), Eromanga, and Mt Isa. The Backyard Explorer team showed participants how to complete a site survey of habitat, vegetation and wildlife using the best practice techniques museum scientists employ in their research. The duration of the workshops ranged from two hours to a full day.

State primary schools involved in the Earth Smart Science School initiative found the Backyard Explorer resources particularly useful in monitoring the biodiversity of their school yard in planning and implementing the biodiversity component of their School Environmental Management Plan. At Chillagoe State School, for example, staff and students are using the Queensland Museum research methods and resources to survey the biodiversity of their schoolyard and are planning an Indigenous Bush Foods garden in partnership with the local Indigenous community.

The 2010 workshops were funded by the Council of Australian Museum Directors to promote the International Year of Biodiversity. The federal Department of Innovation, Industry, Science and Research funded the 2011 workshops through its Science Connections Program (SCOPE) to promote and develop science engagement through school and community links.

Incidentally, the Backyard Explorer project was used as the pilot project for the Herbert River water quality project described above.

For online resources and additional information about the program go to Wild Backyards web page at <[www.qm.qld.gov.au/microsites/wild/index.asp](http://www.qm.qld.gov.au/microsites/wild/index.asp)>

## Appendix 2

### People, place and possibilities for Indigenous science education in the North

#### Unique people

Northern Australia is culturally, demographically and geographically unique. In Queensland (QLD) more than 47,700 Aboriginal and Torres Strait Islander students were enrolled in schools in 2010—which comprises 29.5 per cent of Australia’s Aboriginal and Torres Strait Islander student population and just over eight per cent of QLD state school students (QLD Department of Education and Training, 2011). Across the border, the Northern Territory (NT) has the highest proportion of young people, the highest proportion of Indigenous population (about 30 per cent), and the largest proportion of the population living in very remote locations compared with any other Australian jurisdiction (NT Department of Education and Training, 2011). Such a high and growing proportion of Indigenous people in the NT is significant; they have, or will have, responsibility, through the Aboriginal Land Rights (Northern Territory) Act 1976 for custodianship of 85% of the Northern Territory coastline and half of its land mass (Ramsey et al., 2003). After the NT, Western Australia has the second highest percentage of people living in very remote and remote Australia (see Table 1). However, school retention rates for Indigenous students living in these remote locations across Capricornia are low.

**Table 1: Percentage of population by remoteness classification (Source: NT DET, 2011)**

Jurisdiction	Major cities of Australia	Inner regional Australia	Outer regional Australia	Remote Australia	Very remote Australia
NSW	73.0%	20.2%	6.3%	0.5%	0.1%
Vic	75.2%	20.0%	4.7%	0.1%	0.0%
Qld	59.8%	22.0%	15.2%	1.9%	1.1%
SA	72.8%	12.3%	11.3%	2.8%	0.9%
WA	71.2%	13.4%	9.0%	4.3%	2.2%
Tas	0.0%	64.8%	33.2%	1.5%	0.5%
<b>NT</b>	<b>0.0%</b>	<b>0.0%</b>	<b>56.0%</b>	<b>21.2%</b>	<b>22.8%</b>
ACT	99.8%	0.2%	0.0%	0.0%	0.0%
Australia	68.7%	19.7%	9.3%	1.5%	0.8%

Source: ABS 3218.0 Regional Population Growth, Australia, 2009–10

#### Unique places

The unique physical environment in which most Indigenous students live is a very important consideration in education. Aboriginal and Torres Strait Islander people have an extremely long association with country and this connection to, and caring for country, is culturally and spiritually significant. By way of example, for the Yanuwa people of the southwest Gulf of Carpentaria, ‘indigenous land management practices transcends purely physical interaction and becomes embedded with history, spirituality, and the whole range of human emotions, all of which combine to become expressions of the lived experience of the landscape’ (Bradley, 2001, p. 296).

For school education in northern Australia, Indigenous contexts and issues dominate current educational priorities, policies, strategies and approaches (Robinson et al., 2009). Yet, too often, the place or country in which students live is overlooked. For example, an independent review of Indigenous education in the NT, *Learning Lessons*, highlighted that students' unequal access to quality education and poor school attendance were held to be important determinants of the failure of members of (particularly remote) Indigenous communities to become literate in English (Robinson et al., 2009). Literacy and language learning are inextricably linked as 'words are like mirrors – the meaning we take from them are a reflection of our sense of place – of our sociocultural and academic locations in our current context' Rodriguez (2010, p. xvi).

## Unique possibilities

Recent research on the impact of schools in Australia on learning has shown that 60% of the variation in student learning outcomes rests either between schools or between classrooms within a school while the other 40% is due to either variation linked with individual students or to random influences (Cuttance, 1998; Hill and Rowe, 1996, 1998).

Rodriguez (2010, p. xviii) and contributing authors demonstrate through theoretical insights and practical applications ways that science can be a pathway to teaching literacy and improving teaching pedagogy and students' learning. Brandt (2007, p. 604) asserts that we should view learning spaces more critically and 'look for those elements of common ground and bring to light the ways in which space and time are ordered through our educational practices'. The time is right for reassessing educational practices, especially in northern Australia where unique opportunities exist for improving learning outcomes especially for Indigenous students. Time, is critical here.

Increasing levels of disengagement, especially for Indigenous youth, in school education are cause for concern. With the push to reach literacy and numeracy benchmarks, educators (and policy makers) infrequently recognise the extent to which Indigenous people are disappointed in the failure of western education to conserve and reaffirm aspects of traditional culture (Schwab, 2001).

Educational technologies have created unprecedented opportunities for not only access to resources that would have been inconceivable 10 years ago, but also, potential new learning spaces that ICT affords. While these future learning spaces may or may not be technology-based, it is important to consider the benefits of using educational technologies such as Web 2.0 tools which, for some students 'liberate' them from the confines of traditional chalk-and-talk or pen-and-paper mediums.

Multiple literacies provide a nuanced way of integrating language and science literacy and are particularly helpful for students from non-English speaking backgrounds (Crough, Fogg and Webber, 2012; Rodriguez, 2010). For example, Petheram (2011) concluded that using visual techniques for Indigenous community learning in northern Australia encouraged participants to think and express opinions and perspectives in more open and unconstrained ways compared with solely verbal techniques. Further, "visual products are unique in that they can be very engaging, evoke emotional responses, promote dialogue and provide a platform for stimulating policy-thinking on new and complex concepts in NRM" (Petheram, 2011, p. 221).

Another key element for these future learning spaces is relevance—especially to the lives of Indigenous students. “From a student’s point of view, relevance concerns the degree to which curriculum content and classroom experiences speak to a student’s cultural self-identity” (Aikenhead, 2006, p. 45). Connecting with the environment in which students live—both physical and cultural—is fundamental. Science-based contexts for learning that are culturally inclusive, with a focus on writing and reading, provide ideal opportunities for improving learning outcomes. Culturally responsive science is not new and is well established in Alaska and Canada. Culturally responsive science integrates Native and Western knowledge systems around science topics with aims to enhance the cultural well-being and the science skills and knowledge of students (Stephens, 2000).

In his recent research, Fogarty (2010) demonstrates how learning and working on country overlap in an emergent model of education. In particular, Fogarty (2010) identifies key variables that constitute success factors in the development of a pedagogic framework linking Indigenous land and sea management and remote Indigenous education. They are:

1. The learning is valued and understood by the ‘community’
2. The students bring to the studies a wealth of knowledge regarding the topic enabling them to move from the known to the unknown, or visa-versa
3. Senior Members of the community were able to be involved in the learning
4. The learning is seen as important adult business, not just for kids
5. The learning is rigorous and challenging
6. Students have an option for tertiary entrance
7. Committed enthusiastic teachers

Programs and projects through innovative initiatives like *Inspiring Australia* provide opportunities to not only discuss these critical issues and potential learning spaces but more so, can create the impetus to create new learning spaces that engage ALL students in northern Australia in science education that is relevant to their everyday lives.

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