Talk about a walkabout: pathways and potholes using ICT in science education

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Abstract

Northern Australia is one of the most sparsely settled regions of the world with population density of 0.3 people per square kilometre. Forty-seven percent of students in the Northern Territory live in remote areas. Therefore, due to the tyranny of distance and other factors, ICT plays a fundamental role in science education in northern Australia. The Tropical Savannas Cooperative Research Centre, in partnership with the Northern Territory Department of Education and Training, have developed a range of online resources that focus on valuing and sustaining the northern environments of Australia. *EnviroNorth: Living Sustainably in Australia's Savannas* (environorth.org.au) helps bridge the identified gap that exists between the scientific research in northern Australia and the science education that is taught in schools. Indigenous people have inhabited and shaped northern Australian environments for more than 50,000 years. However, in the mid-late nineteenth century European settlement has accelerated the rate of environmental change considerably. Despite this history, northern Australia is relatively intact ecologically and its biodiversity richness is internationally significant. *EnviroNorth* provides a relevant context for learning in these regions. It also provides a window for learning opportunities in other parts of Australia and the rest of the world. While many teachers and schools throughout northern Australia have embraced ICT for science education, it still poses a challenge for many teachers. Through research and case studies from different schools, this paper addresses some of the pathways, potholes and lessons learnt developing online science education resources and adopting ICT in schools.

Introduction: Challenges and Pathways for Savanna Science

In northern Australia, the population density is extremely sparse with an average of 0.3 people per square kilometre who live in an expansive area covering 1.5 million square kilometres (Garnett et. al., 2008; Woinarski et al., 2007). In stark contrast, Singapore has a population density of 6,814 people per square kilometre and a land area of 710.2 square kilometres (Statistics Singapore, 2009). Yet, less than four hours' flight from Singapore across the Arafura Sea is northern Australia where 47% of schools are located in rural or remote areas (in the Northern Territory); where the teacher retention rates are low; but where challenges for schools in general and science education in particular, are high. Other unique demographics that characterise this region create further challenges. In 2007, 39.5% of students enrolled in school were Indigenous and this percentage is increasing relative to the total student cohort (Department of Education and Training, 2008). The Secondary Education Review highlighted the significance of this high proportion of young Indigenous people in the Northern Territory. In particular, such a demographically young and rapidly expanding Indigenous population has responsibility, through the *Aboriginal Land Rights (Northern Territory) Act 1976* for custodianship of 85% of the Territory coastline and half of the total Northern Territory (NT) land mass. The implications of this for education, and particularly science education for Indigenous students is significant; in order to fulfil responsibilities for "caring for country" Indigenous people would increasingly need to access and engage with Western knowledge systems (Ramsey, et al., 2003). However, the affordances that educational technology provide, offer a critical tool for teachers and students both in these remotely located schools and in other schools throughout the north.

While teachers face enormous challenges in northern Australia, some of these apply to other parts of Australia. For example, a 2005 study commissioned by the Deans of Science found that a large percentage of teachers had not completed a major three-year undergraduate degree in the science subject for which they were responsible (Fensham, 2006). Another study in 2001 - *The Status and Quality of Teaching and Learning of Science in Australian Schools* - identified the need to provide quality curriculum resources for lower secondary teachers and raised the concern of the lack of an interesting, relevant and challenging curriculum that actively engages students (Goodrum et al., 2001). Such needs are indeed the case in northern Australia but are further exacerbated in rural and remote areas where there are difficulties securing teachers. Access to appropriate curriculum resources that are relevant and current to the environment in which the teachers and students live is also a considerable challenge. Not only is this a limiting factor for teaching and learning science in remote schools but also for teachers and students in urban schools.

In response to identifying such needs at both a national and large regional level, the project – Tropical Savannas Knowledge in Schools - was created to develop relevant, current, interactive and authoritative resources for sustainability in northern Australia. It was the first collaborative online project for the Northern Territory Department of Education and Training (NT DET) as well as the first project between the Tropical Savannas Cooperative Research Centre (TS-CRC) and NT DET. Thus no models to adopt or adapt were available that could guide the process for developing the project. However from the outset, the project had two key directives from NT DET: it needed to be an online project (to support all schools) as well as support for the newly implemented outcomes-focused Northern Territory Curriculum

Framework. Subsequently, the focus of such a collaborative project would be the creative development of a dedicated website for, and designed with, teachers and students.

Cooperative Research Centres (CRCs) are an Australian Government initiative established in 1990 to strengthen collaborative research links between industry, research organisations, educational institutions and relevant government agencies. The Tropical Savannas CRC, with its 16 partner organizations, focuses research on sustainable land-management issues in northern Australia.

Hutley and Setterfield (2007) state that while savanna ecosystems are most commonly associated with the great African plains, with huge herds of animals, they occur in over 20 countries, mainly in the wet-dry tropics. Savannas are defined as "grassy landscapes – woodlands with a grassy ground layer, or grasslands – that occur in tropical areas where the climate is seasonally dry" (Dyer et al., 2001 p. 5) and in Australia cover about 25% of the continent as illustrated in Figure 1 (Hutley & Setterfield, 2007). Due to Aboriginal occupation for nearly 50,000 years, coupled with relatively recent European settlement in the last 150 years, northern Australia has been bestowed with a great natural legacy where an extraordinarily large ecologically functioning natural landscape is ornamented by biodiversity richness of international significance (Woinarski et al., 2007). Australia has international commitments to conserve biodiversity which are enacted through the Australian Environment Protection and Biodiversity Conservation Act 1999, and related State legislation (Woinarski et al., 2007). However, the savanna landscapes of northern Australia are in flux where fire, large grazing animals and invasive species have all been implicated as drivers of adverse change (Woinarski et al., 2007). While northern Australia includes three World Heritage Areas: Kakadu, Purnulula and Einsleigh, it remained largely ignored for developing

appropriate resources to support schools, especially those that are web-based and accessible to everyone.

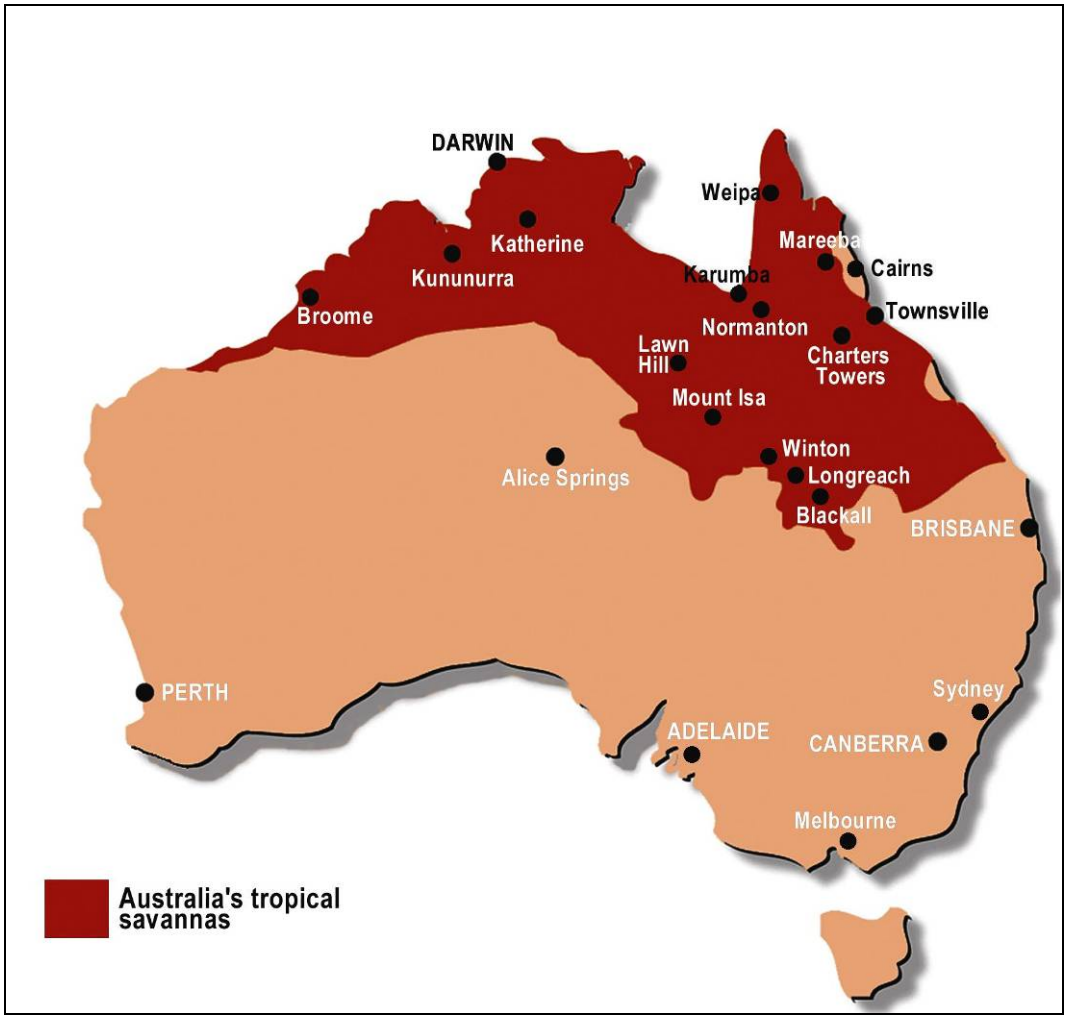

Figure 1: Map of Australia's tropical savannas

Pathways: ICT Affordances for Science Education

Computer-based learning environments provide enormous "potential of a new generation of learners for whom technology *is* the environment and for whom learning means different things" (Sims, 2005, p. 2). Not only do computer-based learning environments provide access to all schools in the Northern Territory, irrespective of their remoteness, but

they also provide an opportunity to adopt different approaches to learning in science education.

Research supports that constructivist beliefs are more conducive to technology integration than traditional beliefs. Becker and Ravitz (1999) identify "constructivist-compatible" instructional activities that incorporate Dewey, Piaget and Vygotsky's educational theories. These include: designing activities around teacher and students' interests rather than in response to an externally mandated curriculum; engaging students in collaborative group projects in which skills are taught and practiced in context, rather than sequentially; focusing instruction on students' understandings of complex ideas rather than on definitions and facts; teaching students to self-consciously asses their own understanding; and engaging in learning in front of students, rather than presenting oneself as fully knowledgeable (Becker & Ravitz, 1999). These constructivist approaches are also supported by research on effective learning that identifies the following three principles: learning is enhanced when learning opportunities are tailored to an individual's current levels of readiness; learning is more effective when it leads to deep understandings of subject matter; learning is more effective when learners are supported to monitor and take responsibility for their learning (Bransford, Brown & Cocking, 2000).

Methods: Savanna Science Pathways and ICT Integration

Collaborative and participatory research methodologies were integral to the design and development of the aforementioned dedicated website. A framework was developed to facilitate the collaborative and participatory nature of the project (see Appendix 1). In February 2007 the website resources, *EnviroNorth: Living Sustainably in Australia's*

Savannas that included three key sections: *Teach Savannas; Learn Savannas* and *Savanna Windows* were launched (see Figure 2).

Figure 2: *EnviroNorth* website homepage and its three key sections.

Methods for Developing Digital Resources

The overall concept and overarching website, *EnviroNorth* drew heavily from ethnography, user observation and user testing approaches to inform its design, structure and development (Futurelab, 2004). The actual learning design modules, Savanna Walkabout about and Burning Issues were underpinned by current research (including: Futurelab 2004; Haughey & Muirhead, 2005; Hedberg & Harper, 1997; Jonassen, 20007; Herrington et al., 2007; McLoughlin & Oliver 2007; and Oliver & Herrington, 2001). The modules' development adopted a modified informant design approach whereby "expert" informants (researchers, students and teachers) were involved in the co-designing of the *Savanna*

Walkabout and *Burning Issues* that helped develop early design ideas and tested prototypes in development. For example, with *Burning Issues*, a small group of educators comprised the expert informant group to develop the initial performance task and continued as key co-designers throughout the module's development. Once a draft prototype was developed, a teacher focus group informed the early design phase. Students were key informants and user tested an early prototype to interact with as well as provide constructive feedback by talking aloud during semi-structured interviews.

Barriers and Enablers for ICT Integration

Common barriers to technology integration include: lack of infrastructure and practical computer access for teachers and students; lack of teachers' confidence and skills; lack of curriculum freedom to integrate technology; social norms in teaching and learning communities that do not support technology integration; and teachers' pedagogical beliefs that do not align with constructivist pedagogy (Becker & Ravitz 1999; Ertmer 2005; Lim & Chai 2007). Conversely, Becker and Ravitz (1999) identify key enablers to technology integration as: opinion climate; information and social support resources; and appropriate educational resources in sufficient quantity.

The online modules and the whole *EnviroNorth* website were developed to align with the Standard Operating Environment in all NT schools. For other educators, the Flash plug-in option and link is available with the online modules. As much as possible, any potential infrastructure barriers have been addressed and continue to be revised. For example, teachers in remote schools identified the need for a CD version of the modules to overcome Bandwidth constraints and unreliable Internet facilities.

Ethnography, user observation and user testing approaches with middle-year students and teachers were conducted as part of the needs analysis of the "*EnviroNorth*" project, confirming and emphasising that an effective interactive learning environment needed to: engage students visually (in appeal); actively challenge students to explore the environment; and cognitively challenge students to work out a problem or similar by transforming information that is presented. This feedback has been incorporated, ensuring that users have the opportunity to explore the democratic learning environment and are actively engaging with it to construct their own understandings. The project (and research) also identified that middle-year students also needed activities that enable them to choose from a variety of possible solutions or approaches to problems. This influenced the adoption of Schwier's (1994) democratic approach to the learning environment, especially in the *Burning Issues* module that is discussed in the next section.

Results: Integrating Savanna Science and ICT

At the heart of the *EnviroNorth* website are interactive multimodal learning modules. In particular, the modules enable constructivist practices by supporting knowledge construction and by enabling learning (embedding authentic tasks and resources) that are related to context, to practice (Oliver & Herrington, 2001) and to the physical world in which the students live (i.e. northern Australia). The learning modules, *Savanna Walkabout* and *Burning Issues* use an inquiry-based approach to engage students in problem solving and issues that reflect the challenges of researchers in the real world. The modules represent authentic settings and current issues and engage students in identifying and challenging their thinking. Issues focus on biodiversity conservation, environmental management and climate

change in the tropical savannas. The learning modules, based on learning design, have been co-designed with teachers, researchers and students to represent credible activity and problem solving within realistic situations resembling the contexts in which the knowledge that the users are learning can be realistically applied (Herrington, Oliver & Reeves, 2003).

Learning Designs

Learning designs represent "a planned set of learning activities resources and supports designed to bring about the development of particular forms of knowledge, skills and understandings" (Oliver and Herrington 2001, p. 99). Sims (2005, p. 6) identifies a learning design for online environments "that emphasizes and acknowledges the role of the learner and embraces the shift to a learner-centred focus." Such a learner-centred approach is fundamental to constructivist learning environments where knowledge construction is supported (Haughey & Muirhead, 2005) and where technologies support an active, constructive, intentional, complex, contextual, conversational and reflective approach (Jonassen, 2000).

Authentic Learning Tasks

Herrington et al., (2007) assert that authentic learning tasks need to provide the types of multiple roles and perspectives that are available in real world challenges. In particular, "the affordances of the web enable alternative perspectives to be readily accessed" and can be targeted for specific tasks (Herrington et. al., 2007, p. 5).

Burning Issues is driven by an open-ended task that is engaging and challenging as well as relevant to any context in northern Australia. The metaphor for the information landscape (Florin, 1990) is a jointly managed national park in northern Australia. Florin relates such information landscapes to "virtual towns or intellectual amusement parks" where

you can “walk along pathways and look at roadside attractions, or you can choose from many different options” (Florin, 1990, p. 30). The module is based on the generic situated problem-focused learning design of review, interpret, construct and justify (Angus et al., 2002). In the *Burning Issues* module, as active constructors of knowledge, learners are required to review available information, interpret appropriate data, construct (and create) a well-argued response to the situated issue and justify the response with appropriate evidence (Angus et al., 2002) The *Burning Issues* learning environment provides an “open” democratic environment that does not support a single best sequence for learning (Schwier, 1994). Instead this democratic learning environment offers students a wide range of learning opportunities that are featured in Table 1. The overarching learning outcomes for *Burning Issues* focus on: scientific literacy; information literacy; critical thinking skills and appropriate technologies as well as literacy.

Authentic Activities

A learning activity, as Conole and Fill (2005) assert, comprises three elements: the context within which the activity occurs; the learning and teaching approaches adopted (including the theories and models); and the tasks undertaken. As far as possible, the activities embedded in both learning modules draw from the ten broad design characteristics of authentic activities that Oliver et al. (2007) identify. For example, in *Burning Issues*, the introductory scenario places the learner in a helicopter flying in to the simulated national park. On landing “you” are congratulated as the newly appointed joint manager for the park. A mobile device with email and map functions is the key global navigation tool. “Your” task is to design a community awareness campaign/product targeting a specific audience about the role of fire in managing northern Australian environments.

Web 2.0 Tools

The emergence of Web 2.0 over the past few years provided opportunities to embed Web 2.0 tools into the performance and assessment task in the more recent Burning Issues module. Students are provided with a Guide (see Figure 3) and teachers are provided with more support tools in the application of Web 2.0 for effective learning in the Teach Savannas section. The *Guide* is structured in two sections: *My Notes* provides scaffolding about how students might approach their public awareness campaign. *My Tools* provides support on some of the Web 2.0 tools learners might like to adopt as part of their campaign. These tools were selected to provide a range of options that align with Multiple Intelligences (Gardner 1999) and their affordance to enhance learning. Becta (2008, p.16) asserts the merits of Web 2.0 tools as they provide "particular opportunities for the personalisation of learning, because they enable activities such as the decoupling of applications and their recombination according to individual preference (the creation of what are often known as 'mash-ups'), and because they allow individuals to create their own resources, which also potentially enables increased creativity in the curriculum".

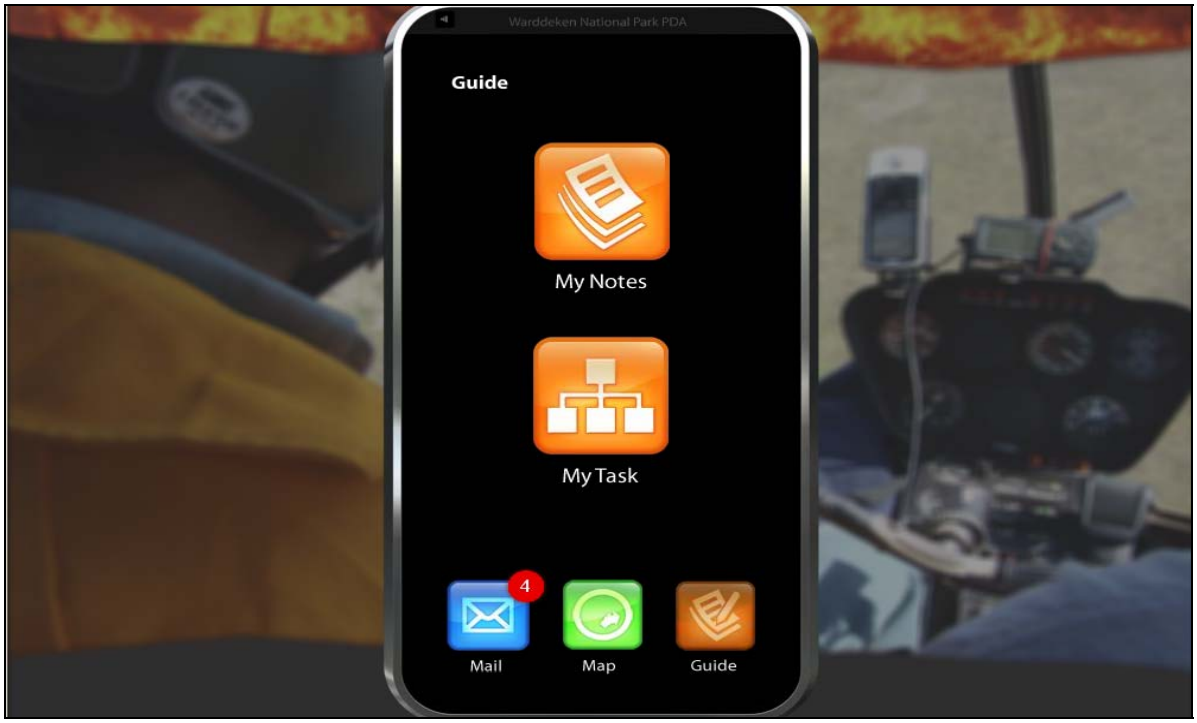

Figure 3: Students' guide in *Burning Issues* supports them to scope and develop their assessment task.

Table 1: The democratic learning environment for Burning Issues

Learning Attributes and Opportunities	**Burning Issues section**
Review information to demonstrate and connect with their prior knowledge using the myth busting maps and questions;	Visitors' Centre
Review a recent community survey graphed results to assist in identifying misunderstandings in the community and a possible target audience for their campaign;	Visitors' Centre
Explore and *interpret* key strategies used for effective communication with visitor interpretation displays;	Visitors' Centre
Explore different peoples' perspectives in order to interpret the range of needs and concerns surrounding fire;	Visitors' Centre
Explore fire survival strategies of key plant species and the impact of burning on various fauna;	Savanna Lookout
Interpret the impact of burning/not burning over periods of time; the impact of introduced weeds and causing hot intense burns;	Savanna Lookout
Value the role that fire restrictions can play in the wider community to protect peoples' lives and property.	Camp Ground
Interpret the impact of traditional indigenous fire practices – ecological, social/cultural and economic;	Outback Cinema
Value the role of using a two-toolkit approach (i.e. western science and traditional burning practices) for controlled burning and to reduce greenhouse gas emissions;	Outback Cinema
Construct an outline of the awareness campaign, demonstrating their understandings;	The Guide
Justify their ideas by identifying how the design would consider key effective communication features and the use of scientific evidence for a specific audience.	The Guide

Computer-based Simulations

Computer-based simulations can provide students with opportunities to –predict-observe-explain using phenomena that otherwise would not be available. Papadouris, Constantinos, and Constantinou (2009) identify the value and role of simulations for students as a powerful tool for exploring, investigating, and interpreting natural phenomena. In *Burning Issues*, students "enter" a virtual world, guided by an "expert" and have the opportunity to manipulate the *Flames* model as illustrated in Figure 4. However, Papadouris et al. signal a cautionary note: "interpreting the results generated by the simulations and conducting meaningful experiments to guide the development of real understanding still posits a fundamental challenge for educators and designers of learning environments that is not specifically addressed by the stimulation environments themselves" (Papadouris et al., 2009, p. 530). In order to guide students in manipulating and understanding the model and its implications for real world situations, a key scientist who developed the *Flames* model, Dr Adam Liedloff provides support. This support is via email messages generated at appropriate times that poses question, emphasise key points and explain the more complex concepts (see Figure 4). Similar experts from their respective fields provide support and scaffolding for students throughout the rest of the *Burning Issues* module. This conversation model (Crawford, 2003) is mirrored in all the other sections of the Burning Issues module both directly and via emails. These "conversations" correspond with key concepts and understandings and/or provide background information that might help breakdown (dissolve) misunderstandings or misconceptions; and/or pose questions to encourage reflective thinking.

The conversation model was also used (although less extensively) in *Savanna Walkabout* throughout the *Termite Trails* and *Research Tracks* sections.

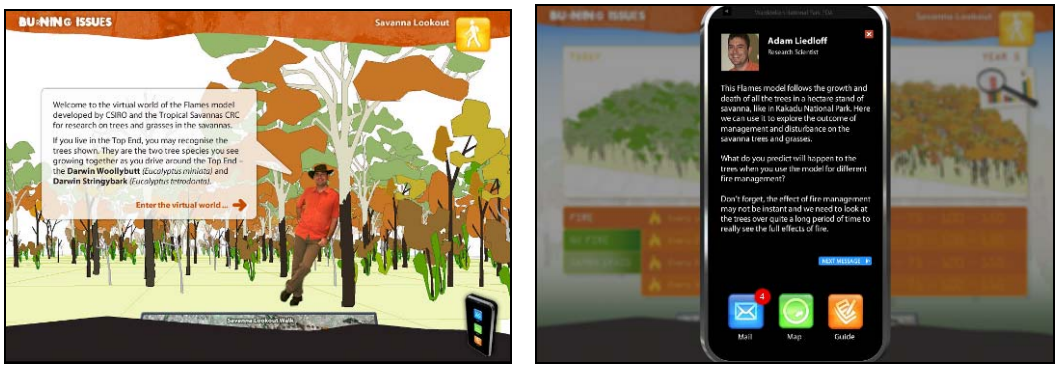

Figure 4: Flames model simulation with timely support via email from the scientist.

Learning Supports

For example, *Savanna Walkabout* is fully supported on the *EnviroNorth* website by a suggested learning plan based on the Teaching for Understanding framework. Overarching understandings or "big ideas", understanding goals that identify what students should know and do – the concepts, processes, skills and key questions – all help to focus the teaching/learning program towards the intended outcomes. The culminating performance task gives students a chance to apply and demonstrate their understandings in a purposeful and contextualised way.

The democratic learning environment is flexible enough to meet a diversity of learner needs depending on the learning focus taken and the offline teaching and learning. Some students will thrive in such an environment and others will need more support than is provided within the online environment. Teachers, in the role of facilitators of learning, guide their learners with the process of making meaning. By targeting specific assessment for and as learning opportunities within the module and/or offline to gain and give feedback, teachers can be

informed as to what focused teaching or support different learners require. Also, the teaching guide is home to a range of further materials including articles (often written accessible language by the scientists), videos, data sets and graphics.

Discussion: Savanna Science and ICT Go Walkabout

Savanna Science programs in schools that incorporate *EnviroNorth* resources and other innovative ICT practices have provided engaging, relevant, meaningful and purposeful learning for students. The following case studies from a primary school and secondary school provide insights into the potential (and realised) potholes, pathways and lessons learnt from integrating ICT in science education with a focus on the *EnviroNorth* resources.

Humpty Doo Primary School

Humpty Doo Primary School is a large primary school with over 400 students located 40 kilometres south of Darwin in a rapidly growing rural area. The school caters for all children from preschool to year 6, including a special education annex. Most children at the school live on two-hectare blocks and small farms but this rural area is undergoing major change. The population has increased significantly over the past 15 years with the once predominately savanna-covered land now undergoing rapid subdivision into small holdings for residences and micro-agriculture.

Environmental and sustainability education is a central part of the school's mission and its curriculum plan, to: encourage learners to examine and interpret the environment, both locally and globally, from a variety of perspectives; encourage learners to participate actively in resolving problems associated with sustainable development in our locality and

the development of our school as a sustainable community; give learners "first-hand" experiences within the environment - our school grounds, our immediate locality and other visits within the region and beyond; and involve learners in finding practical ways of ensuring the caring use of the environment and its resources, now and in the future.
At Humpty Doo Primary, the *EnviroNorth* website has been identified as a preferred primary resource for the teaching of the savanna environment and related issues both locally and globally. Since 2007, the resources have been used to support core teaching in areas including Science, Studies of Society and Environment, English, Mathematics, Learning Technology and Visual Arts. The versatility of the website has allowed for flexibility in the delivery of course content and supports a variety of teaching strategies. The resources have afforded a range of opportunities from teaching a comprehensive integrated unit of work that spans a whole semester to taking advantage of discrete sections of the site for targeted teaching.

The school has adequate technology infrastructure including several student computers in each classroom, access to a mobile trolley unit with several tablet computers, a student computer lab and an interactive white board (Smart Board) located in the Library. Students' exposure to the *EnviroNorth* has been through teacher directed lessons in the classroom using a data projector and individually or with a partner on a PC. In upper primary, approximately 80% of students have access to the internet from home. Funding secured in 2009 will see approximately 14 more interactive whiteboards installed across the school.

EnviroNorth has been used with early childhood classes to introduce them to scientists, scientific method and dispel the myth of the white lab coated scientist. The interviews with the savanna scientists and great number of images of scientists in the field (in *Meet the*

Researchers section of *Savanna Walkabout*) had most students agreeing that being a scientist out in the "bush" looked like a lot of fun. Use of this section (see Figure 5) also provided an engaging way to introduce students to the type of questions that scientists use.

Graphs and data from cane toad and northern quoll research proved an active way to engage students in data that reflected recent environmental changes in their own back yards. This area of the website – *Join the Researchers* - was chosen by teachers to teach focused lessons on enhancing students' visual literacy skills (see Figure 5).

Figure 5: Meet the Researchers and Join the Researcher sections in Savanna Walkabout

Humpty Doo: Creating Digital Presentations Using ICT

As extension activities based on food webs in Termite Trails, students have used both information technology and visual arts to prepare oral presentations for both students and parents. Students have used programs such as *Kidspiration*, *PowerPoint* and *Photostory* to plan, construct and represent local savanna food webs. They sourced suitable images, manipulated and presented information and shared understandings and concerns for savanna ecosystems.

Another integrated program at Humpty Doo included culminating tasks that created "claymations" where students scripted their short films used webcams to produce the footage. These cooperative "claymation" films not only reflected the depth of the students' understanding about, and for, conserving savanna environments but they also provided students with opportunities to embed field work and investigate ecological and historical aspects of the savannas.

Humpty Doo: Reporting and Assessing

Humpty Doo Primary School is working towards storing more evidence of student learning on electronic student portfolios. The *EnviroNorth* website allows evidence to be gathered easily as screen snapshots. The school is currently trialling the effectiveness of this method across upper primary classes.

Taminmin Middle School

Taminmin High School is also located at Humpty Doo. Catering for over 1100 students from Year 7 to Year 12, it incorporates a 75-hectare working mixed produce farm in the areas of stock, horticulture and aquaculture and Woodside Reserve, 150 hectares of natural resource study area where students undertake research and practical studies in conservation and land management. With the adoption of Middle Schooling in 2007, a savannas-focused integrated unit of work was introduced to as a Year 7 theme to engage and connect students with their local environment.

Taminmin is well resourced with many aspects of ICT in the classrooms. New Smart Boards were installed at the beginning of 2008 which facilitated the interactive use of the *EnviroNorth* website in the classroom (as illustrated in Figure 6). However, challenges arose

with the use of individual PCs in student computer labs. Older computers were very slow and several instances of machines freezing hampered students ability to complete set work in the lesson time available.

Incorporating Science, Studies of Society and Environment, English and Mathematics, this Savannas unit of work built on the students' prior learning by utilising the mapping skills developed earlier in the year. Students built on their knowledge of the adjacent Woodside reserve which they visited earlier in the year. Field work was supported by local government weeds officers who supported both teachers with resources and both students and teachers in the field. Links with both home and community were achieved through the development and implementation of their own weed management plan. This process enabled students to take direct action in their own environment by knowing and applying effective weed management strategies.

Figure 6: ICT integration for savanna science at Taminmin Middle School.

Conclusions: Pathways, Potholes, Lessons Learnt and Future Directions

Overcoming many of the barriers to effective ICT integration in science education has been a challenge over the past few years since the *EnviroNorth* website was launched. Conole and Fill (2005, p. 5) emphasise that "the key to online education and constructivism is not whether or not the potential exists, but rather, whether or not the potential will be actualised." Actualising such potential, by overcoming barriers to the implementation of these resources, is a challenge. Unfortunately, implementation has not been supported at a systemic level due to resource shortages (especially people) within the education department. Some infrastructural barriers still exist although they are relatively minor. Confidence and capability in teaching science is still a considerable barrier in many primary, secondary and remote schools in northern Australia where teachers don't usually have any tertiary background in science and as such often don't feel confident and comfortable teaching it. National programs such as *Primary Connections* use various aspects of the *EnviroNorth* resources as part of their professional development programs. Despite these barriers, *EnviroNorth* has been widely supported not only in northern Australia, but throughout the rest of Australia and to a smaller extent, in other countries throughout the world (as reflected in the *EnviroNorth* website usage statistics in Figure 7).

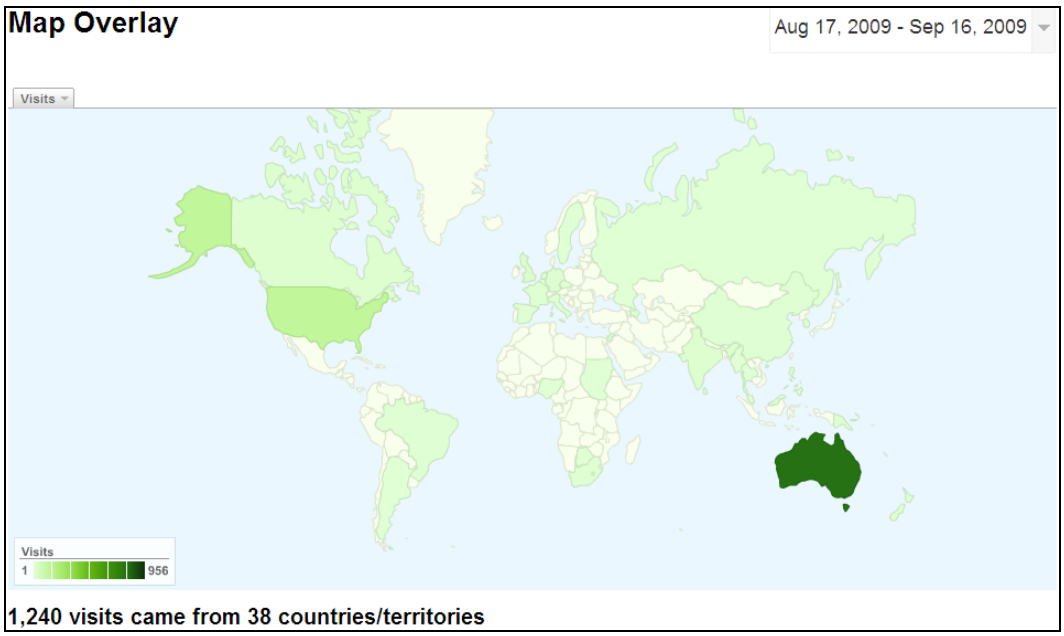

Figure 7: World distribution of visitors to *EnviroNorth* website for one month.

Experience has demonstrated that supporting teachers with professional learning can be problematic. In northern Australia, not only are there vast distances to cover for teachers to meet for the Science Teachers Association of the Northern Territory, there is also difficulty finding appropriate times. While such face-to-face meetings are usually preferable, Web 2.0 tools such as wikis offers greater flexibility for teachers to exchange ideas, experiences and resources irrespective of time and physical location. Such potential opportunities are currently being explored.

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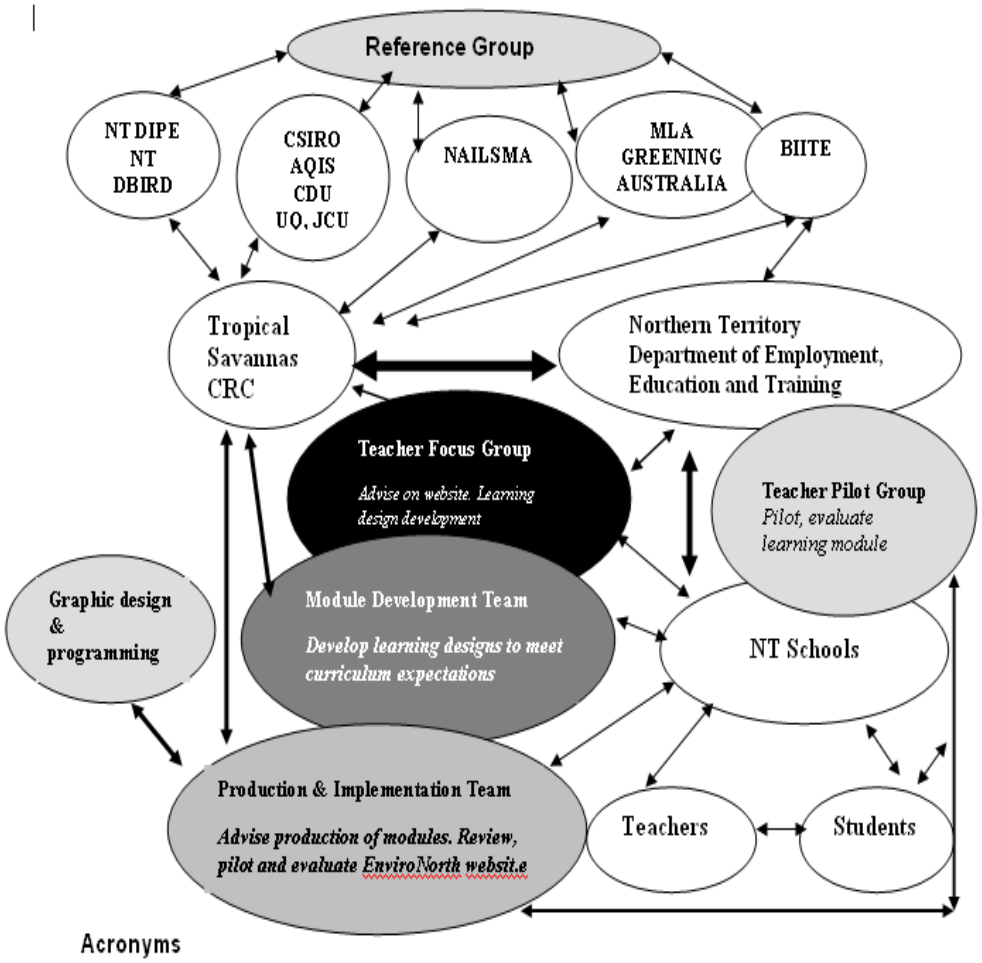
Appendices

Appendix 1



Acronyms

- CSIRO - Commonwealth Scientific Industrial Research Organisation
- NAILSMA - North Australian Indigenous Land & Sea Management Alliance
- NT DIPE, DBIRD - Dept of Infrastructure Planning & Environment, Dept Business, Industry & Resource Development
- JCU - James Cook University
- CDU – Charles Darwin University
- Greening Australia (cf NHT Envirofund Fire Education Project - Website)
- AQIS - Australian Quarantine Inspection Service
- BIITE - Batchelor Institute of Indigenous Tertiary Education
- MLA - Meat and Livestock Australia

Figure 1: Participatory Framework for Material Development and Implementation