Developing a Framework for Interactive Online Environmental Resources

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Abstract

What is a suitable approach for developing online classroom materials with many characteristics of a humanistic perspective in school science? *EnviroNorth* <www.environorth.org.au> is the product of participatory research—involving teachers, students and researchers—between the Tropical Savannas Cooperative Research Centre and the Northern Territory Department of Employment, Education and Training. The resource-rich website links current research for natural resource management in northern Australia to the middle years. This seminar, suitable for middle years' teachers, will explore the:

- need to develop these materials;
- process involved; and
- website's key sections: *Learn Savannas*, *Teach Savannas* and *Savanna Windows.*

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Background

Northern Environments

Environments in northern Australia are often associated with rainforests and reefs and yet this vast landscape—about 25% of the continent—is dominated by tropical savanna ecosystems. Savannas are "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). The ecology and conservation management of these savanna ecosystems is "dependent upon the nurturing of complex and often subtle interactions between biota and their environment" (Woinarski et al., 2005, p. 377). However, "despite an apparent structural integrity, the savanna landscapes of northern Australia are in flux" (Whitehead et al., 2005, p. 369). Fire, large grazing and feral animals, as well as invasive plants have all been implicated as drivers of adverse change (Woinarski et al., 2007)

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. Schools in the north, and in particular the Northern Territory, live in that part of Australia that has the smallest population, the lowest population density, the youngest population, the highest proportion of Indigenous people, the highest level of transience, and the largest proportion of its population living in remote areas (Ramsey et al., 2003).

While northern Australia includes three World Heritage Areas: Kakadu, Purnululla and Einsleigh, it does not often receive the attention that it deserves like other iconic environments in the north such as the Great Barrier Reef and the Wet Tropics. Until recently, the tropical savannas of northern Australia have remained largely ignored for developing appropriate resources to support schools.

Schools' Snapshot

The Northern Territory has a high turnover of teachers particularly in remote areas where the average length of stay is 2.7 years, whereas in regional schools it is 4.06 years and 4.6 years in urban secondary schools. A high level of transience characterises the Northern Territory with an annual migration of eight to ten per cent of the population either moving into or out of the Territory.

"This high level of transience means that young people come in to Territory schools from all over Australia in much higher proportions than occurs in other states and the Australian Capital Territory." (Ramsey et al., 2003, p. 17).

Teachers face enormous challenges in the Northern Territory some of which apply to other parts of Australia. For example, Fensham (2006) refers to the findings from the 2005 study commissioned by the Deans of Science where a large percentage of teachers had not completed a major three-year undergraduate degree in the science subject for which they were responsible. Indeed this is often the case in northern Australia and is often exacerbated in rural and remote areas where there are difficulties securing teachers.

For example, at a recent workshop in the Northern Territory for this project, a science teacher lamented that they were the only teacher with a science (or related) degree background at a school that had more than 650 students, servicing a catchment area the size of the state of Victoria! The teacher talked about the range of challenges that they faced including the students' disengagement with science that by the time the students were in Year 10 they were not interested in experiments or going out in the field but instead preferred the 'predictable comfort' of copying notes from a textbook as they had done in previous years (Pers Comm., 2006)

Forty-seven percent of students in the Northern Territory live in remote areas (Department of Employment, Education and Training, 2006). About 31% of students in the Northern Territory come from a background where another language other than English is spoken (Department of Employment, Education and Training, 2002) with 50% of these Territorians speaking Australian Indigenous languages (Ramsey et al., 2003).

Twenty-nine per cent of the Northern Territory's population is Indigenous with 39% of them younger than 15 years compared with the national average of 20% (Australian Bureau of Statistics, 2003). Almost 39% of the total student enrolment in Northern Territory government primary and secondary schools is Indigenous whereas in other states and territories Indigenous students represent five per cent or fewer of enrolments (Steering Committee for the Review of Commonwealth/State Service Provision, 2003). The Secondary Education Review highlighted the significance of this high proportion of young Indigenous people in the Northern Territory:

> This demographically young and rapidly expanding Indigenous population has responsibility, through the Land Rights Act, for custodianship of 85% of the Territory coastline and half of the total Territory land mass. This clearly has implications for

> Territory education, because as they fulfill responsibilities for "caring for country" and progress towards economic independence and self-reliance, Indigenous people will find it increasingly necessary to access and engage with Western knowledge systems.
>
> (Ramsey, et al., 2003, p. 17)

Resource Response

The Secondary Education Review also identified an inequity in education provision across the Northern Territory's urban, regional and remote schools.

"The critical issue underlying much of this inequity is the lack of, or inequitable distribution of human and physical resources" (Ramsey et al., 2003, p. xii).

"Some students, particularly in remote areas, do not have access to resources that students enjoy in urban and regional centres and even within these areas there is some inequality of access and opportunity." (Ramsey et al., 2003, p. 39).

The Science Learning Area in the Northern Territory Curriculum Framework (NTCF) is "designed to develop scientific literacy that places a high priority on helping all citizens to be interested in and to understand the world around them" (Department of Employment, Education and Training, 2002, p. 341).

It embraces the notion that the primary purpose of school science education is scientific literacy. The Organisation for Economic and Cooperative Development (OECD) defines scientific literacy as "the capacity to use scientific knowledge, to identify questions, and to draw evidence based conclusions in order to understand and help make decisions about the natural world and the changes made to it through human activity" (OECD, 2000, p. 23).

However, Goodrum et al. (2001, p. 182) warn that while Australian educational jurisdictions have developed modern and progressive curriculum frameworks for science education, "there is a considerable gap between the ideal and intended curriculum and the actual or implemented curriculum".

When the outcome-focused NTCF was implemented in the Northern Territory in 2002, curriculum support (Layer 2) materials had not been developed. This was reflected by teachers' needs for outcome-focused science resources: "it's at that upper primary level that you start to expect children to look at land-use patterns, environments, different ecosystems, and the purposes that the land can be put to. But there aren't a lot of support materials for the Northern

Territory, particularly the Top End" (Kane & Jacklyn, 2002, p. 10). Similar needs were also identified in the report, *The Status and Quality of Teaching and Learning of Science in Australian School.* It recommended:

> There is a priority to provide quality curriculum resources for the many lower secondary teachers who need assistance in translating the intended, outcome-focused curriculum into classroom action. The major concern identified at this level is the lack of an interesting, relevant and challenging curriculum that involves students in an active way. Although there are many commercial resources available, teachers do not have time to sift through these to decide their suitability.
>
> (Goodrum et al., 2001, p. 175)

In response to identified needs at both a national and large regional level, the project—Tropical Savannas Knowledge in Schools—was born 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 Employment, Education and Training (NT DEET) as well as the first project between the TS-CRC and NT-DEET. Therefore, no models to adopt or adapt were available that would guide the process for developing the project. However, from the outset the project had two key directives from NT DEET: 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.

Project Participation

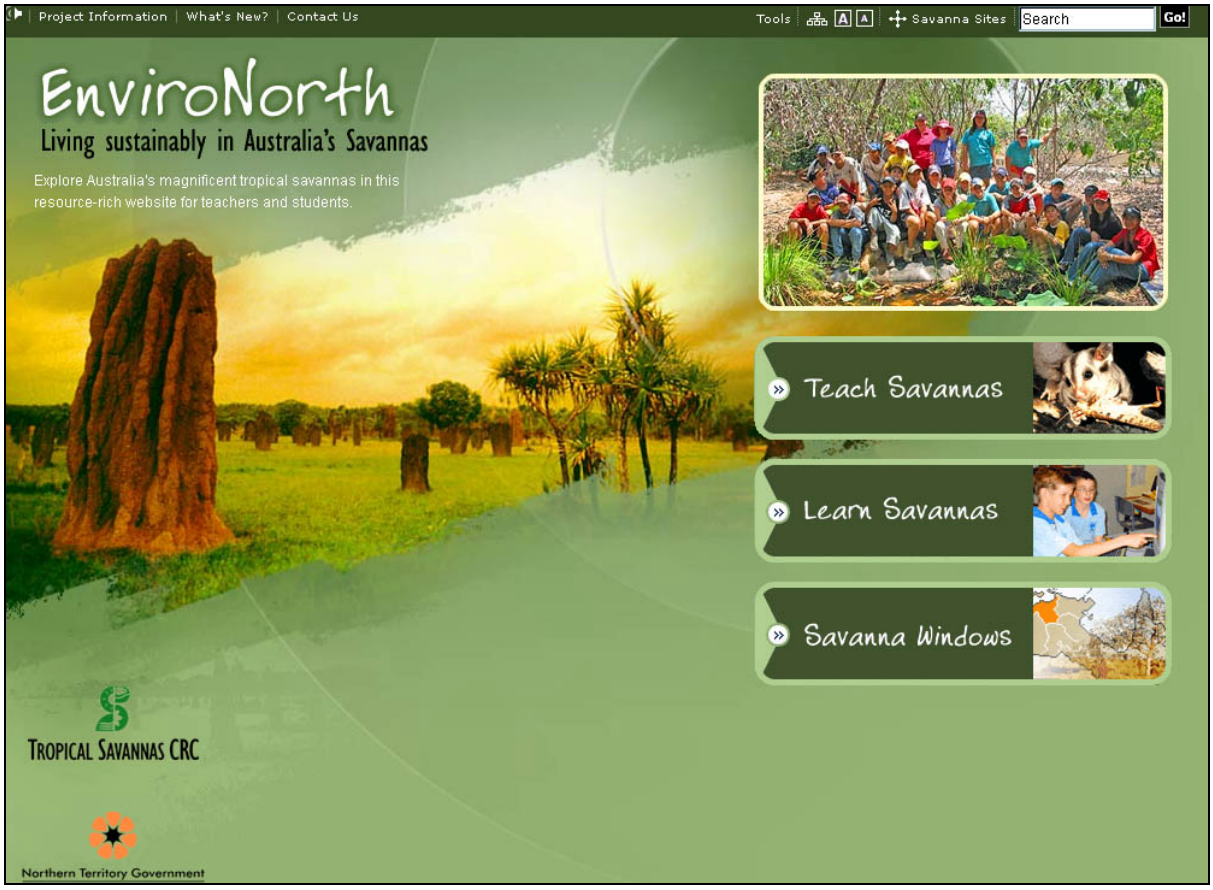
The project adopted a participatory approach from the outset. The breadth of participant involvement continued throughout the three-year project and is reflected in the participatory framework presented in Appendix 1. Extensive consultation including a reference group of educators, science communicators and researchers, as well as a focus group of teachers working in a range of NT schools, advised on features of the new online resource.

Maintaining a participatory approach was always challenging especially when deadlines loom large. Time lags between workshop meetings were often protracted due to the difficulty of securing relief teachers or due to the availability of the multi-disciplinary team members (who generously volunteered their time). Due to the extended time lags between meetings, key ideas were often lost or resurfaced at a later stage in the project. Further, as previously stated, curriculum support (Layer 2) materials had not been developed to support the Northern

Territory Curriculum Framework so scoping content and concept development was time consuming.

Product Pedagogy

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 (Sim, 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 for sustainability. "Reorienting education towards sustainability requires a new view of science, an ecologically focused science, which recognises the interconnectedness of systems, both human and natural," (Fien 2001, p. 18). Complex issues require an integrated approach where "learners can see relationships and links between their learning and use these to make sense of the world" (Wilson & Jan 2003, p. 11). Aikenhead (2006, p. 4) supports this move away from traditional "canonical science" to one that adopts more humanistic science perspectives that give "priority to a student-oriented point of view aimed at citizens acting as consumers of science and technology in their everyday lives". Fensham (2006) refers to a number of humanistic characteristics, based on Aikenhead's (2006) humanistic perspectives that are considered positive approaches to science education. They are: Science as a Story (involving persons, situations, actions); real-world situations for student engagement; focal questions; contexts as the source and power of concepts in science; clearly presented science with related issues of personal and social significance; and personally engaging, open questions for investigation (Fensham, 2006). Further, Rennie (2006) supports community resources as they extend the variety of physical environments where learning may occur, and also extend the range of people and social and cultural circumstances available to stimulate learning. However, Bybee (2006, p. 13) emphasises that: "curriculum materials should be designed with the knowledge that students' current conceptions many not align with recognized scientific knowledge about how the world works and those current conceptions must be engaged and challenged in order for changes to occur". The website, *EnviroNorth: Living Sustainably in Australia's Savannas*, endeavours to capture these principles. Guidelines were constructed (see Appendix 2) to help direct the development of *EnviroNorth* and its three key sections: *Teach Savannas; Learn Savannas* and *Savanna Windows*.



EnviroNorth homepage with key sections: Teach Savannas, Learn Savannas and Savanna Windows

Exploring EnviroNorth

Teach Savannas

Teach Savannas (see Figure 1) provides support materials for teachers using the student modules (in the *Learn Savannas* section). Here teachers can find background information to assist the development of their own understandings about northern Australia's tropical savannas, as well as curriculum support materials. An exemplar learning plan demonstrates one way of using the module to support students' learning. The learning plan is based on the Teaching for Understanding framework (Blythe, 1998). Overarching understandings or 'big ideas', understanding goals that identiy what students should know and do—the concepts, processes and skills and key questions—all help to focus the teaching/learning program towards the intended outcomes.

The learning plan is designed so that students are actively involved in their learning and continually construct/reconstruct understandings in the light of experience as they move from acquisition of facts to the development of deeper understandings. A metacognitive approach help learners take control of their own learning by defining goals and monitoring their progress in achieving them. As well as making these assessment as learning opportunities explicit,

assessment for learning and assessment of learning opportunities where learners can demonstrate their understanding in an observable way, are highlighted and supported with relevant resources such as rubrics. The culminating performance task gives students a chance to apply and demonstrate the understandings in a purposeful and contextualised way. This is very significant, particularly in the light of Aikenhead's findings: "Most students tend not to learn science content meaningfully (i.e. do not integrate it into their everyday thinking) … this evidence-based conclusion is usually explained by the lack of relevance in school science or by a lack of adequate pedagogy (Aikenhead, 2006, p. 27).

Teach Savannas also includes other resources that they could adopt or adapt for their learners to support scientific literacy. For example, interesting articles about current issues are supported with three-level guide strategies to support learners to understand the literal, interpretative and applied meaning of the text (Morris, 1990).

Learn Savannas

This section forms the heart of the website and is home to the learner-centred modules that adopted a constructivist approach. The first module completed, *Savanna Walkabout*, is designed using an Integrated Inquiry model (Murdoch, 1998). Each main sections of *Savanna Walkabout* correspond with the integrated inquiry phases: Tuning In, Finding Out, Sorting Out, Going Further and Making Conclusions (see Appendix 3). The Integrated Inquiry model aligns well with the 5Es Instructional Model – Engagement, Exploration, Explanation, Elaboration and Evaluation (Bybee, 2006).

Many considerations were needed for using such an integrated inquiry but adapting it for an online context. 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 complements the 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, 2007). Interactivity is a key component of a learning design. As Fleming (1998, p. 66) asserts: "interactivity isn't about non-linear navigation or moving animations on the screen. It's about what people can do on the site, what they can participate in, what the site does to address their needs, interests, goals, and abilities." In discussing online environments, Haughey and Muirhead (2005, p. 484) suggest that "learning is iterative and this requires contextualisation of new information, application in new

situations and internal reflection to clarify what did and did not occur. Together, these point to deep engagement with the material." Furthermore, these need to be integral to the design, to ensure best practice (Haughey & Muirhead, 2005).
Other considerations that were addressed included the information and interface design. Cultural inclusivity needed to be integral to the design and many of the design guidelines that McLoughlin and Oliver (2000) offer for Indigenous Australian learners were included. In particular, attention was given to awareness of learners' needs and preferences; multiple perspectives and access to resources; scaffolding and support; self-direction and integration of skills and authentic task design.

Development of *Savanna Walkabout* incorporated the "backward design" process from Wiggins and McTighe (1998). Also, to maximize flexibility with how teachers integrated *Savanna Walkabout* with learning outcomes, each section was designed so that it could "stand alone" thus offering maximum flexibility for teachers to meet their learners' needs. Consequently, the module adopted a complete learning environment comprising a planned series of constructivist learning activities - learning design - that was underpinned by an integrated inquiry-based learning approach (Murdoch, 1998).

Collaborative and participatory research methodologies were adopted to design and develop *Savanna Walkabout*. Teachers, students, researchers, Traditional Owners, an educational design adviser, as well as a graphic design/Flash programmer were involved at various stages during the design, development and implementation phases. Usability testing confirmed that a guide to good interactive website needed to: engage students visually (in appeal), actively challenge students to explore the site, cognitively challenge students to work out a problem or similar by transforming information that is presented. The design phase involved an iterative process whereby activities were storyboarded and the corresponding resources were developed. Ongoing reviews, drawing from a range of expertise including researchers, ICT and English as a Second Language educators were conducted throughout the design and development phases. Face-to-face meetings with the graphic designer and Flash programmer were conducted at key stages of the project. A web log "blog" was also established to help bridge the 4000km divide between the designer and the module development team.

Savanna Windows

This comprehensive section is the culmination of more than 12 years' research in northern Australia. It provides information by topic and by region on a range of issues. It also provides

many links to relevant websites, organizations and people throughout northern Australia, Australia and the World. Many of the articles, that draw on current research but are not research papers, are accessible for people with non-scientific backgrounds. Further, many articles have been written by researchers in their respective field.

Evaluating EnviroNorth

Formative evaluation (Reeves & Hedberg, 2003) was conducted throughout the project on the entire website. In particular, a pilot group of teachers provided feedback from both their perspective and their students'. Formative evaluation was undertaken throughout *Savanna Walkabout's* production. *Termite Trails*, the first section completed, was piloted in a range of primary and secondary schools. Feedback from learners (both students and teachers) found it very engaging. Extensive user testing with both primary and secondary students was conducted to identify navigation and interaction issues. Learners provided constructive feedback that helped resolve problems.

In summary, user testing found positive responses from both male and female students of different cultural and socio-economic backgrounds; the rollover text and glossary terms were accessible to reluctant readers; questions that guided the module invoked curiosity; visuals were appealing and enticing; and the variety of media—image, text, video, audio and animation was engaging for different learning preferences. User testing with teachers was conducted for the *Teach Savannas* section and changes to the section were made accordingly.

Conclusion

Summative evaluation (Reeves & Hedberg, 2003) will be conducted on the website with the ongoing uptake of it in schools. It should be noted that *EnviroNorth*, like all dynamic websites, is constantly growing and developing. Plans are underway for a section on world savannas (in *Savanna Windows*); an illustrated glossary; further learner-centred modules (*Burning Issues, Cattle Country* and *Caring for Country*) as well as an action toolkit and student inquiry (in *Learn Savannas*).

Also, it is very important that *EnviroNorth* is a two-way resource. That is, the website will provide the opportunity for teachers to share their units of work and ideas in the *Teach Section* (Ideas from the Classroom) and possibly students will have the opportunity to share their ideas and actions with other students in *Learn Savannas*.

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Appendix 1

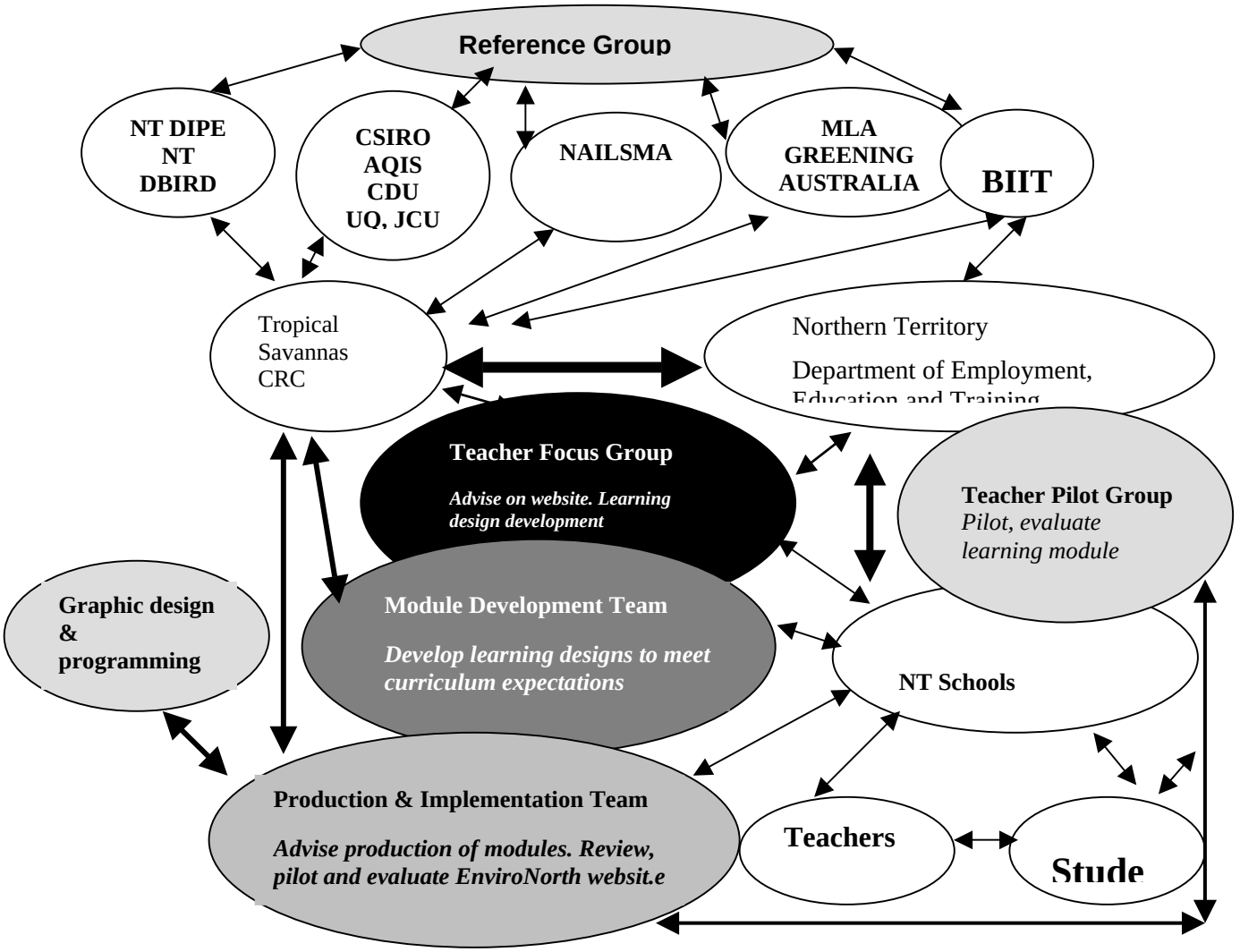

Figure 1: Participatory framework for curriculum support material

Abbreviations

- 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

Appendix 2

Best Practice Principles

EnviroNorth environmental curriculum and learning website has been developed from a range of principles derived from National priorities in Australia, Northern Territory Department of Employment, Education and Training systemic initiatives and current educational theory and research. These principles will inform the processes by which support materials are designed, developed, evaluated and accessed.

Principle: Integrity

- Accurately represents ways of knowing and conceptualising the domain addressed by the support material.
- Uses the language and symbols of the domain.
- Supports learners' deepening of knowledge and ability to engage with the domain.
- Incorporates the opportunity for reflecting on the diversity of perspectives in a fair and accurate manner, within the domain.

Principle: Designed for Teaching

- Uses language that facilitates understanding by the range of teachers' experience and knowledge in the NT.
- Incorporates all components to enable materials to be accessible and useable.
- Explicitly states the purpose, process and intended outcomes that may be achieved.
- Describes the pedagogy and instructional techniques that create an effective and inclusive learning environment.

Principle: Learner Centred

- Clearly articulates the learners for whom the material is designed.
- Incorporates pedagogy that promotes and sustains learner engagement.
- Acknowledges and reaffirms cultural identity.
- Builds learning processes from existing skills and knowledge towards the desired outcomes.
- Provides specific language support for learners whose first language is not Standard Australian English
- Clearly articulates how the learning experiences described allow for demonstration and documentation of evidence of learning.

Principle: Life-Long Learning

- Clearly describes the elements that require explicit teaching of literacy and numeracy in order to provide learners with opportunities for successful demonstration of their learning.
- Incorporates and reflects the processes and modes of learning that are embedded within the Exit Outcomes.
- Connects learning experiences to real-life contexts and opportunities in order to ensure learner participation is both meaningful and purposeful.

Principle: Scientific Literacy

- Promotes critical and creative thinking
- Promotes community responsibility and encourages decision making, taking action and applying skills to issues
- Enhances scientific literacy
- Represents multiple knowledge systems (i.e. western scientific and indigenous)
- Promotes an openness to inquiry – i.e. uses inquiry-based model

Best Practice Principles Cont.

Principle: Reliability and accuracy

- Provides fair and factually accurate scientific and environmental concepts, problems and issues
- Information is derived from primary sources that provide context, documentation and explanation
- Content has been reviewed by a range of experts in the appropriate fields or have participated in the development in another way
- Achieves high editorial standards

Principle: Deep understandings

- Fosters awareness of the natural and cultural environment
- Promotes an understanding of environmental concepts, conditions and issues
- Provides awareness of feelings, values, attitudes and perceptions with issues
- Represents a range of scales – local, regional, national and global scale

Principle: Design

- Promotes visual literacy (i.e. appeals to user through graphics, text, aesthetics, images etc)
- Audio/sound is innovative and used effectively
- Uses a range of narrative elements such as humour, mystery

Principle: Usability

- Learning is intuitive (user knows what to do and how to do it intuitively)
- Selected technology is appropriate to the audience, purpose and context for which it is intended.

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Appendix 3

Table 1: Summary of Integrated Inquiry for Savanna Walkabout

Section	Essential Questions	Outcomes
Living Savannas ***(Tuning In)***	What do we know about tropical savannas?	Learners: • Reflect on their existing knowledge and understandings of what are tropical savannas. • Develop understandings of the key characteristics of the Tropical Savannas biome. • Understand that unsustainable land use threatens biodiversity in savannas throughout the world.
Termite Trails (*Finding Out, Sorting Out*) Meet the Termites Interdependence Impacts	What is the social structure of termite colonies? Why are termites in many ways the life-blood of savanna ecosystems? How do weeds, feral animals and wildfire impact on savanna ecosystems?	Learners: • Understand that communities of plants animals and people live and interact in Australia's tropical savannas. Insects, especially termites as decomposers and herbivores, play an important role in Australia's tropical savannas. • Develop skills to build simple food chains and food webs based on real world examples. • Understand some of the key factors that threaten Australia's tropical savanna ecosystems include: introduced species (weeds & feral animals) and changed fire regimes.
Research Tracks ***(Going Further)*** Meet the Researchers Join the Researchers	Who are some of the people researching biodiversity issues in Australia's tropical savannas? What's happening to the northern quoll in Kakadu National Park?	Learners: • Understand that researchers working scientifically have a major role to play so people can make well-informed decisions about planning and management to ensure we have healthy ecosystems and conserve biodiversity. • Participate in exemplary scientific research in an authentic context by "working scientifically" under the guidance of Dr John Woinarski to identify and solve a current threat to biodiversity in northern Australia. • Understand that Indigenous Knowledge and Western Scientific Knowledge both play a key role in understanding and conserving biodiversity. • Understand that they can make a difference to conserving biodiversity and consider how they could get involved in current issues.
Savanna Treasures ***(Making Conclusions)***	What opportunities exist to conserve our biodiversity?	Learners: • Understand the challenges for biodiversity conservation in the Tropical Savannas biome. For example, it is in Australia's social, environmental and economic interest to conserve our biodiversity. • Understand that it takes less energy and fewer resources to conserve ecosystems and the goods and services they provide, than it does to restore the ecological systems after they have been altered. • Act individually or as part of a group or organisation and make lifestyle choices and take actions that help protect biodiversity.