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PRIMARY ENGLISH TEACHING ASSOCIATION PETA

Primary Connections – Linking Science with Literacy

PENNY HUTTON

A trial program that aims to improve science teaching and learning has had a marked impact on how teachers and students approach science in the classroom – and has also improved literacy skills. Teachers who used the program found that their students were motivated to develop their research, reading and writing skills in order to explore their topic and express their findings.

In August 2000 the Department of Education, Training and Youth Affairs (DETYA) released *The Status and Quality of Teaching and Learning of Science in Australian Schools*, the report of a research project into science teaching. The Australian Academy of Science embraced the report's recommendations (see below) and initiated the *Primary Connections – Linking science with literacy* program, developing units of work for all years of primary schooling.

The *Primary Connections* program was trialled during 2005 by teachers in 56 schools throughout Australia.

Nunawading Primary School was one of the schools selected to trial the units of work. The school serves a diverse community in the eastern suburbs of Melbourne and has a population of 130 students of whom approximately 60% speak a language other than English at home.

Two of the trialling teachers were Sara Hudson, who teaches a Prep/Year 1 composite class, and Richard Fly, who teaches a 3/4/5 class.

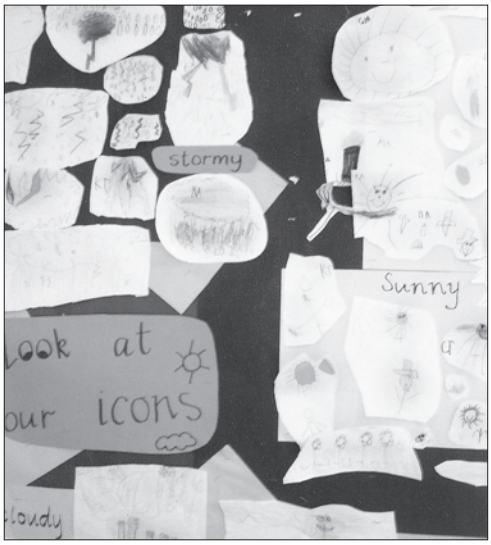
Sara Hudson's Prep / Year 1 class

Sara based her Term 1 program around the "Weather in my world" unit of work. Sara found the unit allowed her to implement a number of strategies to ensure all children settled happily into the school year. The units have a strong focus on building cooperative learning and team skills. This emphasis helps develop important friendships and social skills throughout the school. To assist the Prep. students in their orientation to school, Sara teamed them with 'buddies' in Year 5. The students then worked with their buddies to construct and try out wind meters and observe, talk and read about the weather conditions in their environment. These activities helped the Prep. students to develop confidence in their new surroundings and gave them additional support in the playground.

Students with wind meters

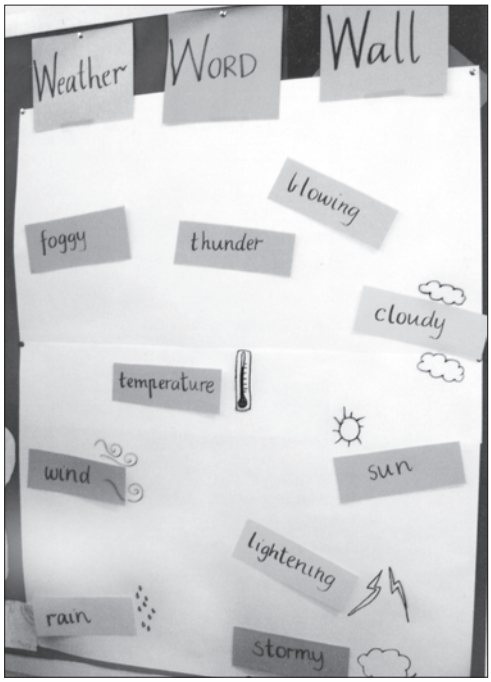
The unit also proved to be a very useful jumping off point for developing literacy skills. Sara had implemented a literacy block in her classroom and found that the science learning that her students were engaged in provided an ideal opportunity to teach literacy skills. She selected related Big Books and poems for shared and guided reading, and for inclusion in the take-home reading program. Children were then able to talk to

their parents about what they had been learning and to talk about how the weather is described in television news reports and in newspapers. The students designed their own weather icons and used these and their developing vocabulary to write a weather forecast each day during a shared writing session.



Weather icons

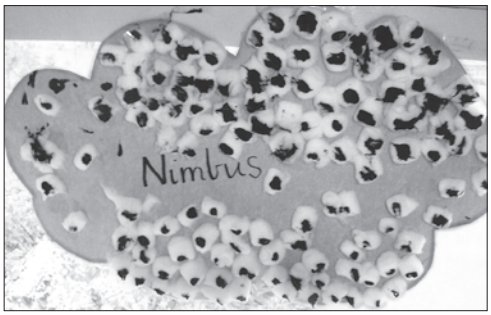
Sara and her class constructed a Word Wall of the new and technical vocabulary they were encountering and using. Students often referred to the Word Wall to support their reading and writing.



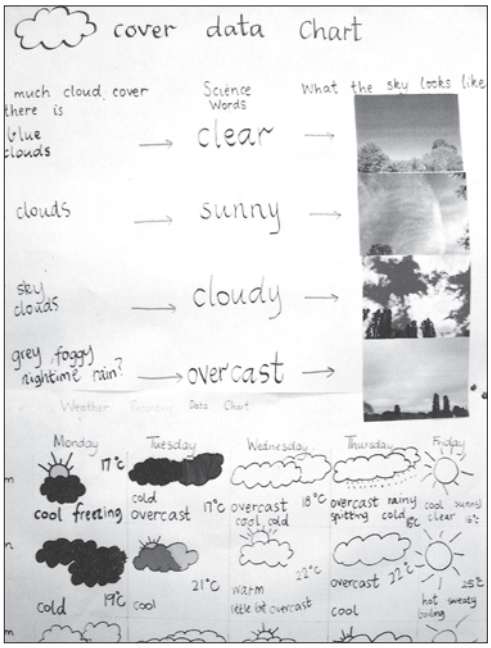
Word wall

Sara has noticed that her students have developed their descriptive vocabulary as a result of the work they have done. They are also able to transfer their new vocabulary to other situations.

The students now have a vocabulary to talk about the weather and how it affects their lives. They enjoy being able to recognise and name the different types of clouds, using their observations to predict when it might rain or to plan everyday activities.



Nimbus cloud



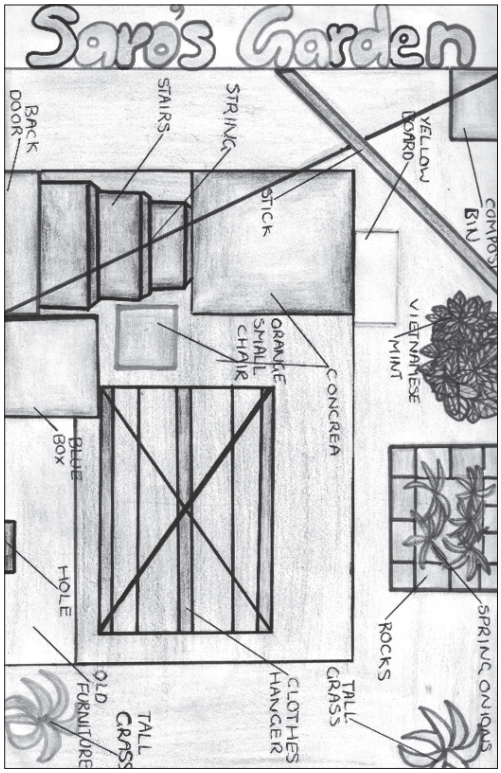
Cloud cover data chart

Even though Sara's class has now completed other units in science this year, her students still discuss and record their weather daily and have become more aware of the ways in which they are affected by the weather.

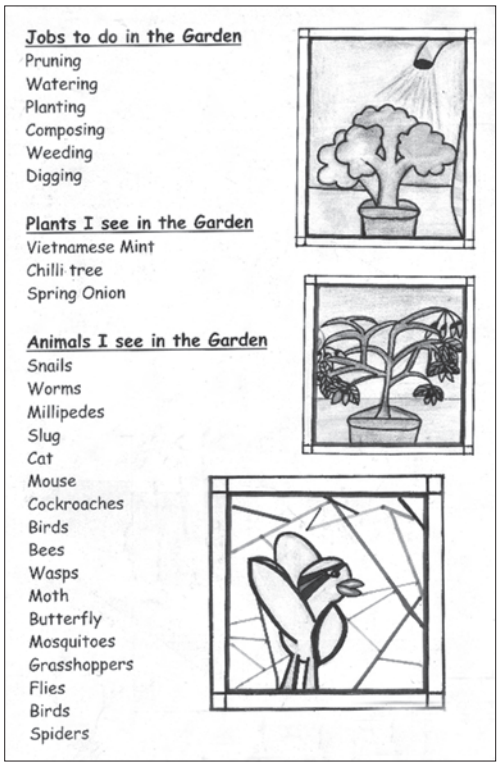
Richard Fly's Year 3 /4 /5 class

Richard's 3/4/5 class began the year by studying the unit "Plants in action". At the start of the unit each child took turns in taking a 'garden buddy' and a disposable camera home. The children were required to take the 'garden buddy' on a tour of their home garden, or another of their choice, and to record information about the garden in writing and photographs. The children drew plans of their gardens and recorded information about them in a science journal.

Garden buddy



Plan of garden



Jobs to do in the Garden
Pruning
Watering
Planting
Composing
Weeding
Digging

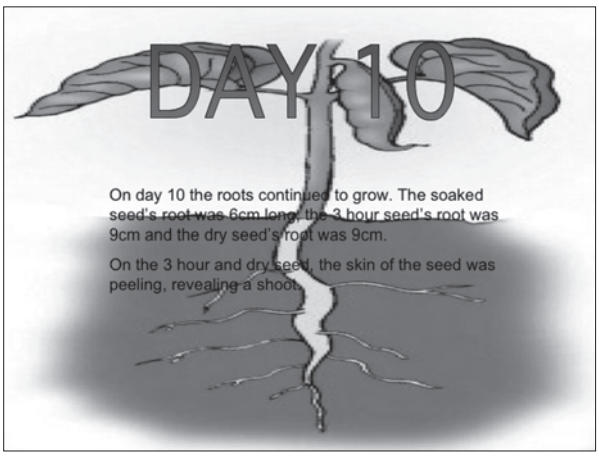
Plants I see in the Garden
Vietnamese Mint
Chilli tree
Spring Onion

Animals I see in the Garden
Snails
Worms
Millipedes
Slug
Cat
Mouse
Cockroaches
Birds
Bees
Wasps
Moth
Butterfly
Mosquitoes
Grasshoppers
Flies
Birds
Spiders

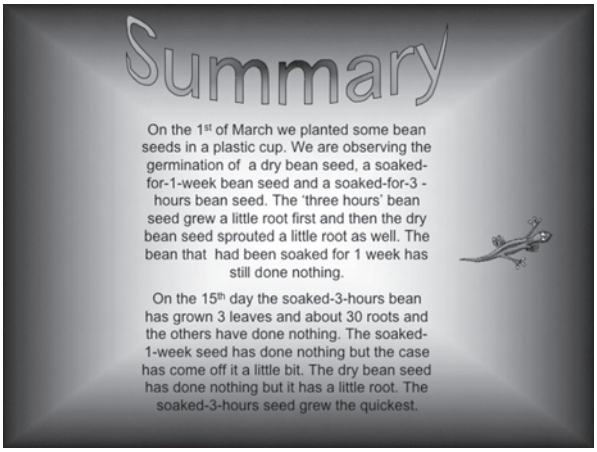
Extract from science journal

At the beginning of the unit, the class constructed a KWLH chart which they consulted regularly and updated or refined as their knowledge developed. The 'How we know' section was particularly important in teaching students to think scientifically and to draw evidence-based conclusions.

What we know	What we want to learn	What we learned	How we know



Students' report, in PowerPoint, on the germination process – day 10



Students' summary, in PowerPoint, of the process

Richard was keen to find opportunities for his students to experience authentic purposes for researching, reading and writing, so he teamed his class up with students from Mount Pleasant Primary School. The two classes visited the Botanical Gardens to learn from experts about plants and how to grow them. They then conducted a collaborative project using Net meeting to develop joint PowerPoint presentations about the life cycles of plants. They also spoke to other gardening experts to build their knowledge of plant growth.

The students' interest and enthusiasm was such that the school decided to embark on a school garden project. They are now developing a school garden where they are growing fruit and vegetables.

Students building garden

The school's ultimate aim is to have a garden of healthy foods which the children will be able to cook themselves, then experience the social and cultural values of a shared meal. Parents have become involved and have assisted by building fences and helping the children to prepare the garden beds. The children have researched the principles of sustainable gardens and the best types of plants for their particular conditions using internet and library resources. Their keenness is such that many want to stay after school to continue working in the garden.

Richard has found that the unit has been invaluable in giving the students real contexts and purposes for their writing. The language involved in describing the science of their work has become meaningful and concrete. The children have written in a variety of genres and forms. These include using labelling conventions to correctly label diagrams; writing procedural texts; summarising scientific texts; and constructing multi-modal texts. The children also developed PowerPoint presentations of the life cycle of plants to share with other classes.

Literacy sessions also include ICT activities where students retrieve information from appropriate websites, engage in online quizzes, navigate through sites to gather information, develop concept cartoons and use Learning Objects.

By providing a real motivation to read and write, Richard has noticed a significant improvement in the literacy skills of his students and in their knowledge of and interest in science.

In August this year the school was invited to participate in a Science Showcase at a local high school. All classes contributed displays of their work and some of Richard's students were on hand to explain and describe what they have learned so far and what they are working to achieve.

Teachers' findings from the trial

Richard and Sara both found that students gained a real sense of purpose for their work and an increased motivation to achieve when given opportunities to present their learning to genuine audiences.

This finding was echoed by other teachers trialling the units who also reported that the quality of the oral and written work produced by their students improved significantly when they had a real purpose, based on shared and relevant experiences, for speaking, reading and writing.

Background to the Report

The impetus for *Primary Connections* arose from a research project that investigated science teaching in Australian schools. Its report, *The Status and Quality of Teaching and Learning of Science in Australian Schools*, was released by DETYA (now the Department of Education, Science and Training) in August 2000. The research set out to investigate and report on three domains:

1. To describe an ideal picture of what excellence in science teaching and learning would look like.
2. To report on what was actually happening in classrooms across the country
3. To develop a set of recommendations that would help close the gap between the 'actual' and the 'ideal'.

In order to develop a vision of what would be considered 'ideal' science teaching and learning, a description of scientific literacy was developed by the principal researchers:[1] *"Scientific literacy is a high priority for all citizens, helping them to be interested in and to understand the world around them, to engage in the discourses of and about science, to be sceptical and questioning of claims made by others about scientific matters, to be able to identify questions and draw evidence-based conclusions, and to make informed decisions about the environment and their own health and well-being."*

1 Associate Professors Denis Goodrum and Mark Hackling from Edith Cowan University and Professor Leonie Rennie from Curtin University

This description became the goal that would drive all further work. The group then worked with the statement to describe an 'ideal' view of teaching and learning in science.

Classroom teachers will find few surprises in the nine themes of the 'ideal' vision for science teaching. Indeed the same themes could be applied to any area of teaching. They include:

1. a relevant curriculum
2. inquiry based teaching and learning
3. effective assessment practices which complement good teaching
4. an engaging and motivating teaching-learning environment
5. teachers as life-long learners, supported and well-resourced
6. teachers of science with a recognised career path based on strong professional standards
7. excellent facilities, equipment and resources to support teaching and learning
8. class sizes which allow teachers to employ a range of teaching strategies and to meet the needs of all students
9. science and science education valued by the community and the school curriculum.

However, research discovered an 'actual' picture that is quite different. The researchers found that all states and territories have curriculum statements which provide well-articulated pathways for students to develop scientific literacy and achieve learning outcomes in science, yet these documents are largely ignored.

They also found that the amount of science being taught in primary schools varies greatly. In some primary schools science is rarely taught. In those primary schools where it is taught, the students are mostly engaged in student-centred and activity-centred tasks. While students reported high levels of satisfaction with these lessons, the researchers found that there is little progression in learning between grades. At best, students are given a variety of intrinsically interesting and motivating experiences but these experiences are not related to a planned progression of science learning.

As students move from primary to secondary school, one of the things that they most look forward to is learning science. However, their early enthusiasm is often quashed when they experience a curriculum which they do not perceive as relevant or engaging and which is not connected with their interests and experiences. Their disappointment with secondary school science is reflected in the continuing decline in students who are choosing to study science in the post-compulsory years and those taking up science courses at tertiary level.

Through interviews and surveys the researchers found that the greatest reason for science being neglected in the primary curriculum was that many primary teachers did not feel confident in teaching science to their classes. A significant number had not studied science in their final years of high school and did not feel that their pre-service training had equipped them to teach science effectively.

Secondary science teachers reported feeling "undervalued, under-resourced and overloaded with non-teaching duties". More than half of them reported that they would like a career change which would take them away from teaching.

Recommendations

The researchers formulated nine recommendations to address the disappointing state of science teaching in Australian schools. The recommendations included:

1. raising community awareness of the importance of science education in schools
2. providing incentives for attracting and retaining science teachers
3. increasing funding for pre-service science education
4. supporting the professional development of teachers to improve science teaching
5. supporting the development and implementation of professional standards in science teaching
6. the provision of appropriate conditions and resources for teachers to teach science
7. reforming assessment practice so that assessment will inform teaching and improve learning
8. national collaboration in the development of curriculum and professional development resources
9. that another review be undertaken in five years time to gauge the extent and success of change arising from the report.

These recommendations are based on five premises. They are:

1. the purpose of science education is to develop scientific literacy
2. the focus of change is on closing the gap between the 'actual' and the 'ideal' pictures of school science education
3. teachers are the key to change
4. change takes time and resources
5. collaboration between education jurisdictions is essential for developing quality science education resources.

Response to the report

The Australian Academy of Science embraced the five premises and responded to Recommendations 1, 4, 6, 7 and 8 by initiating a project, now known as *Primary Connections – Linking science with literacy*.

The Academy drew together a Reference Group of experts in the teaching of science and the teaching of literacy, representing all Australian education authorities and professional associations. PETA is a Reference Group member. From the outset the Reference Group expressed their commitment to producing a resource which would reflect best practice in pedagogy and current research in literacy and science teaching. It was also considered imperative that the resource should include a strong and well-developed professional learning component for teachers. Core to the development of the resource was the belief that teachers needed to feel confident and competent as effective teachers of science and science literacy. Since considerable work has already been done in the teaching of literacy and multi-literacies in schools, teachers needed to see how they could use an area in which they already felt confident and competent as a springboard for taking on something new.

The units of work

Units of work were developed by teachers for all years of primary schooling. The units cover the four strands of science learning that are common to all states and territories: *Earth and Beyond*, *Energy and Change*, *Life and Living* and *Natural and Processed Materials*.

The units also incorporate Indigenous perspectives, use information communications technologies and make links between science learning in school and students' community experiences. Each unit follows a five-phase constructivist model of learning. This approach is based on the belief that students learn best when they are guided, through carefully structured learning experiences, towards understanding new concepts and knowledge. In order for students to be able to make connections between what they already know and what they are learning the units are organised into five phases: *Engage, Explore, Explain, Elaborate* and *Evaluate.*

In addition, learning outcomes for science and literacy were developed for each unit and diagnostic, formative and summative assessment practices were integrated.

The model on the following page demonstrates the ways in which science and literacy learning were planned for and implemented throughout the units.

This model can be adapted for any learning area.

Cooperative learning principles are considered integral to the effective learning of science and science literacy and have been embedded within the units.

Each unit of work also includes a professional learning component for teachers, so that they are provided with sufficient background knowledge to teach the content, and have access to a range of resources for further information.

The units build on the everyday literacy practices that students are already familiar with, and use these practices to teach the new literacies of science in explicit ways. This approach enables students to see the links between their world and their values and the science they are learning. In particular, the units provide relevant contexts for students to simultaneously demonstrate their knowledge of science and of literacy.

Trialling the units

While the units were being written, a comprehensive professional development program for teachers was also being planned. In late 2004 the Academy sought expressions of interest from schools to be involved in a trial. Fifty-six schools were selected and in January 2005 teachers from these schools suspended their summer holidays and travelled to Canberra for a week of intensive professional development. The teachers had an opportunity to work with leading science and literacy educators to learn about science and literacy teaching and learning, and to reflect on how they might implement their new knowledge and understandings in their teaching practices. The teachers were also introduced to the first units of work which they would trial in their classrooms in Term 1.

	Engage	Explore	Explain	Elaborate	Evaluate
Science processes	Students interact with materials to predict, observe or relate to prior experiences	Students engage in hands-on activities to explore a new concept	Students identify patterns in data, interpret and explain data, draw conclusions	Students plan, investigate to test ideas in new situations, collect, analyse, interpret and explain data, draw conclusions	Students review and reflect on learning and processes used and synthesise ideas
Literacy practices	Students discuss ideas, share understandings, make connections with other areas of knowledge	Students listen, read, view and interpret texts, debate ideas, record information, compare and contrast ideas	Students write, draw, design, role-play, give oral presentations, carry out library and multimedia research Students use subject-specific vocabulary	Students debate, discuss, explain, present, write, read, view, interpret	Students develop written and multimodal presentations and construct texts, synthesising past understandings and demonstrating new knowledge
Literacy products, representations, demonstrations	Science journal records, oral reports, multi-modal texts	Science journal records Verbal reports	Students develop posters, PowerPoint presentations, cartoons, dramas, brochures, letters, formal written and oral reports, animations, ICTs	Students design multi-modal texts Create diagrams, graphs, charts, maps, tables, 3D models	Students design multimodal texts, create 3D models, give group and individual reports, make representations and demonstrations
'How to' resources	Science journal Questioning skills Cooperative learning skills	Read expository texts Record observations Construct and record graphical representations, diagrams, charts Identify purposes of texts, intended audience Critically evaluate texts	Design presentation, integrating multiple modes of presentation Interpret texts	Literary products (as above) Design an open-ended investigation	Use PowerPoint Give a verbal report Develop critical appraisal skills
Assessment purposes	Diagnostic, eg responses to questions, concept cartoons	Diagnostic, eg student discussion	Formative, eg evaluate literacy product against unit outcomes	Formative, eg monitor developing understandings against unit outcomes	Summative, eg work sample assessed against unit outcomes including peer and/or self-assessment

Implementation of science and literary learning throughout the units

Ongoing professional support for teachers was seen as imperative in bringing about real and lasting changes in the teaching of science, so follow-up meetings were scheduled to be held in all mainland capital cities in mid-term 1, at the end of term 1 and mid-term 2. Teachers used these opportunities to share their successes and challenges and to learn from each other. The meetings also provided opportunities for the teachers to increase their knowledge of science and of literacy strategies with input being provided by academics, including one of the original researchers, Associate Professor Mark Hackling, and Associate Professor Vaughan Prain from Latrobe University. The teachers were also given time to plan further teaching units and to contribute to ongoing data collection about the efficacy of the program. Their feedback has been vital in making sure that the final versions of all units of work will give teachers clear directions and provide a sequence of challenging and motivating experiences for students. The trialling teachers also participated in an online discussion group where ideas, strategies, resources and tips were exchanged.

Findings from the trial

In July 2005 the Australian Academy of Science presented an Interim Research Report to the Australian Government Quality Teaching Program. The report was based on information gained from the teachers and schools that had trialled the program. The report found that *Primary Connections*, after only six months of implementation had:

- made statistically significant increases in teachers' confidence with teaching science
- made large changes to teachers' practice, eg. increased frequency of teaching literacy skills needed for learning science; increased use of

diagnostic assessment; increased frequency of hands-on activity work; increased use of digital cameras as a tool for teaching and learning

- supported a considerable increase in science teaching time and the status of science in the school curriculum
- received a very positive response from students
- according to both teachers and students, increased the quality and amount of learning of science and literacy
- resulted in large and statistically significant increases in learning achievement in sample classes studying the *Plants in Action* unit.

The Academy has now put a proposal to the Federal Government for funding for a third stage of the project. If successful, it would see the program made available to all schools.

Testing standards of scientific literacy

In 2006 a sample of Year 6 students from across the country will participate in a national test of science literacy, the *National Assessment Program – Scientific Literacy*. This test follows the *National Science Assessment* which was administered in October 2003. A report of the results of this assessment can be found on the Ministerial Council on Education, Employment, Training and Youth Affairs website. This assessment established a desirable standard of scientific literacy for Australian students in Year 6 and measured students' proficiency against the standard.

The 2006 test will again measure students' performance against the standard. The results will be reported nationally and comparisons will be made with the 2003 results. Further testing is also planned for 2009 so that longitudinal data can be collected.

Conclusion

The *Primary Connections* project is of particular interest to PETA as we have a long association with and commitment to exemplary literacy teaching in all fields. Our own *Special Forever* project is one contribution to science literacy, making explicit the links between literacy teaching and learning about the environment. We will watch with interest, and support, the progress of *Primary Connections*.

References

Department of Education, Training and Youth Affairs (2001) *The Status and Quality of Teaching and Learning of Science in Australian Schools*. Commonwealth of Australia.

Ministerial Council on Education, Employment, Training and Youth Affairs (2005) *National Year 6 Science Assessment Report 2003*. Commonwealth of Australia.

Australian Academy of Science & Department of Education, Science and Training *Primary Connections – Linking science with literacy*.

About the author

Penny Hutton has taught in primary, secondary and tertiary settings. She is currently the Senior Assessment Officer for English at Educational Assessment Australia. She has particular interests in the effective teaching of literacy within specific subject contexts.

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The Federal Government has just announced that funding for Stage 3 has been approved. This will allow the Academy to develop further units of work and a program of professional learning. This will assist educational jurisdictions in all states and territories to support schools that express an interest in participating in the program.

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