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ABSTRACT

The high expectations for scientific literacy for all students demands a certain quality of science education in lower secondary education. This program focuses on supporting teachers in implementing this new curriculum. There are three interconnecting components of the program: (1) curriculum resources; (2) professional development; and (3) participative inquiry due to the difficult and complex structure of the teacher change process. (Contains 14 references.) (YDS)

A Proposal for a Collaborative Australian Secondary Science Program

This proposal was prepared by Associative Professor Mark Hackling and Associate Professor Denis Goodrum of Edith Cowan University, and Mr Fred Deshon of the Education Department of Western Australia.

This proposal was developed as a feasibility study sponsored by the Australian Academy of Science, the Education Department and Curriculum Council of Western Australia, and Edith Cowan University. The proposal was developed in collaboration with the Australian Science Teachers Association, Curriculum Corporation, and education departments, curriculum councils and boards of studies from the Australian Capital Territory, New South Wales, Queensland, South Australia, Tasmania, Victoria and Western Australia.

Collaborative Australian Secondary Science Program

Introduction to the Proposal

The community has high expectations of science and science education. Adaptability, flexibility and the ability to transfer and apply ways of thinking will be paramount to life and work in the 21st century. Problem solving ability, ability to communicate and use information technology and scientific literacy will have a high priority

(OECD, 1998).

The curriculum frameworks and syllabuses being introduced, or recently introduced, by Australian States and Territories have as a common heritage the national science statement and profile. This common heritage is reflected in the definitions of, and rationales for teaching science which emphasise the need to develop scientifically literate citizens who can understand the world around them, use scientific approaches to investigating and problem solving, and contribute to public debates on scientific issues that affect the community.

To realise these expectations of scientific literacy for all of our students, the importance of a quality lower secondary science education cannot be overstated. The high expectations of high school science held by primary school students are often not met; lower secondary science often involves lecturing, note taking and working from the text (Speering & Rennie, 1996). These unmet expectations appear to be partly responsible for declining attitudes to science in the early high school years, and may be a contributing factor to the declining enrolments in the physical sciences in upper secondary and tertiary science education. The level of student engagement in learning tasks appears to be linked to perceptions of challenge; challenge being enhanced by difficulty, importance, relevance and novelty of tasks, extent of control over learning and opportunities for active involvement (Baird, Gunstone, Penna, Fensham & White, 1990). Much of secondary science with its traditional and theoretical content delivered in a transmissive and teacher-centred style has limited potential for challenge and student engagement or for developing the learning outcomes described in the States and Territories' curriculum frameworks, or for developing scientifically literate citizens.

In response to this problem, the Australian Academy of Science, the Education Department of Western Australia and Edith Cowan University agreed to conduct a feasibility study to explore the potential of a national collaborative program to support lower secondary science teachers implement changes to teaching and learning consistent with contemporary best practice.

In the first phase of this study, information was gathered from all States and Territories on the development and implementation of curriculum frameworks and syllabuses in the Science Learning Area, on whether there is a common need for a major initiative, and an interest in establishing an Australian collaborative project. The Australian Science Teachers' Association was also consulted to provide the opportunity for the Association to take a major role in any initiative that may result from the feasibility study. Analysis of curriculum documents revealed a shared view about the nature and purpose of school science. Consultations resulted in commitments from all States and Territories to participate further in the feasibility study.

The second phase involved a meeting of science curriculum officers from all States and Territories, the Executive Secretary of the Australian Academy of Science, science education researchers from Edith Cowan University and the University of Western Sydney, the executive of the Australian Science Teachers' Association, and a representative from the Curriculum Cornoration~ The nurnose of this meetin2 held in Darwin in Julv was to identify

A third phase, involved a group of key stakeholders who met in Canberra for two days in November and one day in December to develop this proposal and the attached briefing paper. The meetings involved representatives of education departments, curriculum councils and boards of studies from the Australian Capital Territory, New South Wales, Queensland, South Australia, Tasmania, Victoria and Western Australia working with representatives from the Australian Academy of Science, the Australian Science Teachers Association, the Curriculum Corporation and science educators from Edith Cowan University and the University of Western Sydney.

Purpose of the Collaborative Australian Secondary Science Program

To support teachers in implementing a science program that is consistent with the type of science described in State and Territory curriculum frameworks and syllabuses, using pedagogies consistent with contemporary best practice, providing students with a challenging and engaging experience of school science, and achieving internationally competitive learning outcomes for students in the compulsory years of secondary schooling.

Components of the Program

To successfully implement the new curriculum frameworks in a way that presents science as described in the definitions and rationales there is a need to reform classroom practice and at the heart of this change, is teacher change. Teacher change is a difficult and complex process. Research indicates that teacher change can be facilitated by professional development, the provision of curriculum resources to support teachers as they attempt to adopt new approaches to teaching science, and engagement in participative inquiry to monitor, analyse and reflect on their classroom practices and the learning that is occurring in their classrooms. The Program will therefore have three interconnecting components; curriculum resources, professional development, and participative inquiry.

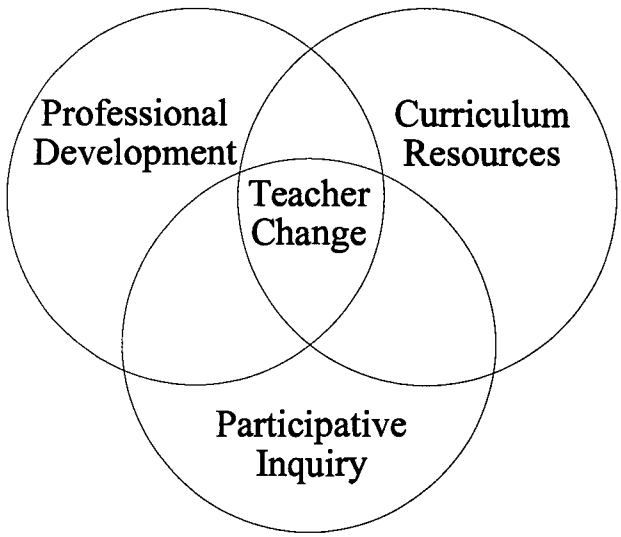

Figure 1. The contribution of professional development, curriculum resources, and participative inquiry to teacher change.

Teachers' understanding of the new pedagogies and classroom practices and their use of them in teaching, learning and assessment will be developed through professional development, participative inquiry and exemplified through concrete examples in a curriculum resource.

Guiding Principles

Focus on teacher change

If secondary science teachers, who have been trained to teach traditional science in traditional ways, are to accommodate to the new classroom practices required by the curriculum frameworks and syllabuses they must undergo significant personal and professional change. Science departments will also need to undergo significant cultural change to create learning communities that work together to reflect on, and change their classroom practices. This Program will therefore be focussed on supporting teachers and science departments reform their practices.

Flexibility

The Program needs to be flexible to enable:

- all school systems and sectors, all schools, and all teachers to have equitable access to the Program. The curriculum materials need to be flexible to ensure teachers can construct a sequence of learning experiences that is relevant to all their students, regardless of their geographical location, cultural values, socioeconomic background or gender. This will require the Program to have the flexibility to provide a curriculum relevant to all students and be accessible and useable by all teachers.
- individual schools, school districts, systems and sectors to access and utilise the Program at a point that services their need. Individual schools, systems and sectors have teachers with different levels of knowledge and skill in teaching practice and curriculum planning, and different cultures and structures that impact on the most effective curriculum for their students and the most effective means to provide support for teacher change.

- education systems and sectors to utilise existing structures and cultures for supporting schools to implement the Program. State and Territory education systems and sectors have differen(structures for supporting schools, and are at different stages of curriculum development and the provision of support for implementation.

Provision of a relevant and integrated curriculum for all students in today's world

Science learning must be relevant to students' interests and needs as they leave formal schooling in the $_{21}$st Century. Improved attitudes towards science and scientific literacy for all students is a central focus of all State and Territory curriculum statements and will be a key principle in the development of this Program.

Many curriculum statements refer to the contribution that science learning makes to students developing broad outcomes of learning. These are described in various ways, such as key competencies or overarching outcomes. Many statements also acknowledge that the learning of science does not occur in isolation from other learning areas and connections facilitate complementary learning. In the context of an evolving focus on the middle years of schooling in many States and Territories, and a focus on whole-school planning, the connections within science and with other learning areas, and the contribution of science to the broad outcomes of learning needs to be made explicit to support teachers. This Program will therefore make strong connections with relevant aspects of other areas eg. literacy, numeracy, technology and learning technologies.

Curriculum materials as concrete exemplars for practice

Research studies conducted in association with the Australian Academy of Science demonstrated the value of using exemplary curriculum resources with professional development to support teachers attempting to change their classroom practices (Aubusson, Watson & Brown, 1997; Goodrum & Hackling, 1997; Watters, Diezmann & McRobbie, 1997). Curriculum resource materials can provide concrete exemplification of the approaches and strategies to be adopted. This Program will therefore develop curriculum materials that illustrate how an effective science program can be planned, delivered, monitored and evaluated. These materials will support teachers as they come to understand the changes they are attempting to make, and help them achieve the student learning outcomes described in the curriculum frameworks.

The resources will help teachers structure learning so that students will learn about science, by engaging students in doing authentic science set in meaningful contexts. Where appropriate, links will be developed between science, technology and society with a problem-based focus to learning so that scientific attitudes, skills and understandings are not learned as an end in themselves but to help students understand the world around them, make decisions in relation to the application of science in their own lives, and contribute to public debates about science related social issues.

Accurate and balanced science

Students need to be presented with an accurate, balanced and an insightful view of the important problems and research questions that are being investigated by professional scientists. This Program will include science that is relevant to industry, work and the Australian context and impacts on people's lives; their health, environment and workplace.

Professional development

Research on professional development has identified characteristics of unsuccessful and successful approaches. Fullan (1991) indicates that: one shot workshops without follow-up support for teachers or follow-up evaluations are ineffective; topics are frequently selected by people other than those for

whom the inservice is to be provided and consequently programs rarely address the needs and concerns of participants; and most programs are provided for subject coordinators from different schools in a district without recognition of the needs of individual schools or directly involving the classroom teachers in the professional development experience.

To be effective professional development programs must

1. address issues of concern recognised by the teachers themselves;
2. be as close as possible to the teachers' working environment;
3. take place over an extended period of time;
4. have the support of both teachers and the school administration;
5. provide opportunities for reflection and feedback;
6. enable participating teachers to feel a substantial degree of ownership;
7. involve a conscious commitment on the part of the teacher;
8. involve groups of teachers rather than individuals from schools; and
9. use the services of a consultant or critical friend (Lovitt, Stephens, Clarke & Romberg, 1990, p. 234).

Professional development made available through this Program will therefore:

- involve the whole science department;
- be on-going;
- focus on the needs of participating teachers;
- provide opportunities for analysis and reflection on classroom practices;
- provide all teachers, regardless of geographic location, school structure, or student population with opportunity to access professional development at the time of need;
- provide for the changing needs of teachers as they grow in their understandings and skills; and
- involve teachers in the development of professional development resources and facilitation of professional development workshops.

Participative inquiry

The involvement of teachers working collaboratively within science departments reflecting on their current practices, recognising new possibilities and identifying issues to be addressed can engage them in forms of inquiry into their own professional practice. Participative inquiry involves cooperative participation in the construction of professional knowledge relevant to the context of the workplace. Groups working together in open and authentic communication inquire into, and reflect on professional knowledge and practices, constructing understandings that are a guide to action. Participative inquiry is therefore an empowering and transformative process (Reason, 1998). The strengths and benefits of various forms of participative inquiry include being focussed on the participant's own practice, bringing about change in and developing understanding of that practice, ownership of and commitment to the change, and enhanced collaboration between colleagues. This Program will therefore resource teachers with the strategies and analytical tools to enable them to participate in monitoring, reflecting on and evaluating changes in their classroom practices and impacts on learning outcomes.

Teacher input

For change to be effective, the curriculum materials and professional development must address the issues that inhibit teachers undertaking change. The resources must be prepared for the conditions

under which schools typically operate. To ensure they are real for teachers, teacher input into their development is a critical feature. This can be accommodated through intensive trialling of all components of the Program by those teachers most in need of support for change. This feedback will be incorporated into the Program.

Valuing teachers as professionals

This Program recognises that teachers are the professionals who initiate and manage change appropriate to the requirements of educational systems, the context of the school and the community it serves and the needs of the students. The resources developed by this Program do not represent an imposed curriculum, but a set of resources from which teachers can select to support them and their science department colleagues as they set a path for reforming their curriculum and classroom practices.

Earth and Beyond

- models of inquiry;
- techniques for gathering data about their classroom practices;
- techniques for probing students' understandings, attitudes towards science, and perceptions of classroom climate, and for assessing students' attainment of skills; and
- tools to facilitate analysis and reflection.

As teachers analyse their current curriculum and practices, plan for change, and implement new strategies or curriculum approaches they will need to access these tools of participative inquiry to monitor the success of the implementation, and, in collaboration with their colleagues, develop modifications or enhancements to the implemented curriculum or classroom practices.

Curriculum resources

One of the challenges of any busy teacher is the selection and sequencing of interesting and worthwhile activities. To support teachers, 'units' will be developed and comprehensively trialled to ensure they maintain student interest and are easy for teachers and students to use.

Each 'unit' will represent a sample learning program comprising a carefully structured, yet flexible sequence of learning experiences related to a conceptual theme. More resources will be provided than would be required so that teachers and students can select those activities most relevant to their needs and interests. The activities will be sufficiently open and flexible to allow for different student needs.

It is proposed that sufficient 'units' should be developed to support the four years of compulsory secondary science education. The units should generally have a developmental sequence and fit within an overall conceptual framework developed collaboratively by the States and Territories. Units could be developed in four developmental stages, designated Yellow, Green, Blue and Red.

Units at the lower stages are likely to be multidisciplinary (eg Units Gi, G2 and B2), however, some units at the Red stage are likely to be based on a single discipline (eg Unit R3). Units could be integrated round the major ideas and contexts that are common across State and Territory frameworks and syllabuses. The horizontal (eg Unit Gi to Unit G2) and vertical (eg Unit Gi to Unit B2) developmental sequences, should be sufficiently robust so that teachers can select units in a way that is meaningful for their circumstances and needs. Each State and Territory should be able to make connections between their syllabus and the conceptual framework for this Program.

Learning features

It is anticipated that the curriculum resources would probably need to incorporate:

- a teaching-learning model that takes account of students' existing beliefs and understandings, such as the SEs model (Bybee, 1997), to facilitate the development of students' understandings;
- a teaching-learning model, such as the cognitive apprenticeship approach involving modelling, scaffolding and coaching (Collins, Brown & Newman 1989; Hennessy, 1993), to facilitate the development of students' problem-solving and investigation skills;
- an outcomes focus;
- materials to structure formative and developmental assessment;
- cooperative group learning;
- learning in relevant contexts;
- development of conceptual understandings, understanding of the nature of science, scientific attitudes and processes of working scientifically; and
- developing literacy through science, and learning science using information technologies.

These features represent elements of a new paradigm for teaching and learning secondary science.

Format

It is expected that the curriculum resources would consist of a teacher's resource pack and a student activity resource. The format of the materials would be determined by the needs of teachers and students ascertained through comprehensive trialling, the available and anticipated technology, and economics.

It is anticipated that the teachers resource pack would include a wide range of web-based materials supported by hard copy, video and CD ROM. The teachers' resources would need to include some of the following:

- an outline of the conceptual underpinnings and philosophy of the program;
- an explanation of the conceptual framework that structures the 'units' of work that make up a four-year program of learning;
- explanations of the learning models and how they are exemplified in the materials;
- descriptions of a range of teaching-learning strategies and illustrative examples showing how they are incorporated into the Program's resources;
- strategies and resources for assessment; and
- information about suggested lessons and activities, useful hints to ensure the activities are successful and the learning experiences are effective, and ideas for adapting activities for different student groups.

Sets of tailored summative assessment resources would need to be developed to support teachers from each State and Territory so that assessments would be explicitly linked to the various outcomes and standards frameworks.

It is anticipated that the student resources would probably need to:

- provide contextual and stimulus material for students, pose questions, engage students and elicit their existing beliefs, lead students into a wide range of activities and investigations of different types, and scaffold the generation of work samples and portfolios that can be used for assessment purposes;
- be available in hard copy and electronic formats so that they are flexible and can be used in a number of different ways, eg be copied for student use in the form supplied, or adapted by the

school, or used as a resource from which activities and approaches to learning can be selected and used to supplement an existing program; and

- be used in conjunction with other existing resources such as student expository texts.

The needs of secondary science in the new millennium are quite different to those identified for primary science in the early 90s. To meet the needs of systems, schools, teachers and their students, the curriculum resources will need to be far more sophisticated and flexible than those produced by the Primary Investigations project. It is recognised that none of the stakeholders has any interest in developing another expository text, laboratory manual, or set of black line masters.

It is likely that the student resources will be web-based. It is suggested that the Web Page acts as a filter for teachers from different State and territories so they can access the version of the materials that shows explicit links to their particular framework or syllabus.

Possible Time Line for the Program

1998	Develop the final proposal and identify key players and sources of funding.
	Establish the management structure for the Program.
1999	Plan the outline of the curriculum 'units', the professional development modules and the participative inquiry tools.
	Identify and establish writing teams for curriculum, professional development and participative inquiry resources.
	Commence preliminary writing. Select trial schools.
2000	Trailing and continued writing of curriculum, professional development and participative inquiry resources.
	Implementation of initial professional development and participative inquiry modules.
2001	Revision based on feedback from trialling and continued writing.
	Further trialing of resources.
	Further implementation of professional development and participative inquiry modules.
	Curriculum resources for the Yellow and Green Stages to be available for implementation.
2002	Further revision.
	Continued implementation of completed resources.

References

Aubusson, P., Watson, K. & Brown, G. (1997). ***Enhancing lower*** *secondary science: The trial of a curriculum package combined with a professional development program . A research report prepared for the Australian Academy of Science.* University of Western Sydney.

Baird, J., Gunstone, R., Penna, C., Fensham, P., & White, R. (1990). Researching balance between cognition and affect in science teaching and learning. *Research in Science Education, 20,* 11-20.

Bybee, R. W. (1997). *Achieving scientific literacy: From purposes to practices.* Portsmouth, NH: Heinemann.

Collins, A., Brown, J. S. & Newman, S. E. (1989). Cognitive apprenticeship: Teaching the crafts of reading, writing and mathematics. In L. B. Resnick (Ed.), *Cognition and instruction. Issues and agendas* (pp. 453-493). Hillsdale, NJ: Erlbaum.

Education Department of Western Australia (1996). *Lower secondary science resources: The development of a conceptual description for future lower secondary science curriculum resources.* Perth: Education Department of Western Australia.

Fullan, M. G. (1991). *The new meaning of educational change.* New York: Teachers College Press.

Goodrum, D. & Hackling, M. (1997). *Secondary science investigations research project:*

Final report. Perth: Edith Cowan University.

Hennessy, 5. (1993). Situated cognition and cognitive apprenticeship: Implications for classroom learning. *Studies in Science Education, 22,* 1-41.

Lovitt, C., Stephens, M., Clarke, D. & Romberg, T. (1990). Mathematics teachers reconceptualising their roles. In T. Cooney & C. Hirsch (Eds.), *Teaching and learning mathematics in the J990s. 1990 Yearbook* (pp. 229-236). Reston, VA: NCTM.

Reason, P. (1998). Three approaches to participative inquiry. In N. Denzin & Y. Lincoln (Eds.), *Strategies of qualitative inquiry.* London: Sage.

Science Functional Expert Group of the OECD (1998). *Framework for assessing scientific literacy.* OECD PISA national project.

Speering, W., & Rennie, L. J. (1996, April). *Transition to secondary school: The impact of curriculum change on students' attitudes to science.* Paper presented at the meeting of the American Educational research Association, New York.

Watters, J., Diezmann, C. & McRobbie, C. (1997). *The reality of knowledge construction: An investigation of the impkmentation of an instructional sequence based on constructivist principles.* Centre for Mathematics and Science Education, Queensland University of Technology.

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