The Academy of Science's New Primary School Project in Science, Technology and Environment

NEVILLE FLETCHER

The Academy of Science is currently developing an integrated program in science, technology and environment for Australian primary schools. This program, based upon a similar program developed in the United States under a National Science Foundation grant by the Biological Sciences Curriculum Study, is currently being trialled by 12,000 children and 700 teachers in 38 schools around Australia. The program will be available for adoption on a whole-school basis in 1995, following extensive in-service courses for teachers starting in late 1994.

Few informed people could doubt that there are problems with science education in Australia - the fact that similar problems exist in many Western countries provides little comfort and seems to be the result of shared social problems and a faulty common educational philosophy. The Australian govemment has recognised the importance of good educational practices in all areas, and various working Parties are producing National Statements and National Profiles in all major subjects that are intended to guide those preparing syllabuses and teaching materials at all levels from kindergarten to the end of high school. These Statements and Profiles are still not in final form, but have been widely discussed. Despite significant remaining criticisms, their content in the science and technology areas is generally reasonable up to the end of the "compulsory" stage of schooling year 10 in most states - but the drafts are most unsatisfactory for the final two years, largely because of a complete lack of new science content and exclusive attention to social issues. Many people are working hard in an attempt to remedy this situation.

Most people would agree however that, vitally important though the final years of high school are in producing students equipped to enter scientifically or technically oriented occupations, many of the attitudes and interests of students are formed at primary school level. Here the situation is particularly bad in practice, whatever the goals spelt out in the National Statements. Few primary school teachers have had any formal contact with science themselves after year 12 and, as a result, are hesitant to introduce anything but the most elementary biology into classroom teaching. Even for teachers who would like to introduce some science teaching, the complications involved in devising suitable classroom activities act as a severe deterrent.

Against this background, the Australian Academy of Science, through the Australian Foundation for Science, of which the AIP is a member, is carrying out a major project to produce educational materials in science, technology and environmental studies for primary school children. There are, of course, several notable Australian programs providing teaching materials for primary school science, and several whole primary science courses. As will become clear presently, the Academy program is rather different from any of these, and is able to take advantage of some of the experimental and reading materials from other sources.

This is a new role for the Academy, which has previously produced only materials aimed at the final two years of High School. *The Web of Life* revolutionised Australian biology education at this level some 25 years ago when it was introduced, and its successor *Biology The Common Threads* which was introduced in 1990 is now placing biology education in a more modern context. Biology, of course, can have a mass of Australian content and this accounts, in part, for the tremendous success of these texts. The same is true, for a much smaller school cohort, of the geology text *Perspectives of the Earth* which was produced in 1983. The Academy has also produced texts at this level in Chemistry, in General Mathematics and in Human Health, and an Environment text will be published later this year. There have been several moves to produce a physics text, but these have ▷

Professor Neville Fletcher is a CSIRO Chief Research Scientist at the RSPSE, Australian National University. He is also chairman of the Academy of Science primary school science project committee.

not come to fruition for various reasons, a major one of which is the need for a common approach to the subject by at least the largest states.

What, then, is the Academy project aiming to do to meet the needs of Australian teachers and children for a good grounding in science at primary school level? How is the project being carried out? When can we expect to see something in the schools?

Educational Philosophy

Any educational philosophy should be compounded from a clear view of desired outcomes, a knowledge of children and the way in which they learn, and a clear appreciation of what is possible in a classroom situation. The Academy project has a clear position on all these matters.

The objectives of science-related education at primary school level are several. Firstly children should perceive science as an activity and body of knowledge that is relevant to everyday activities. They should understand what it means to ask sensible scientific questions about matters of importance, and how answers to these questions can be found by observation and experiment. They should begin to acquire a body of reliable knowledge about basic scientific principles, in a non-formal way, and should develop skills in observation, measurement and analysis.

It is a sound educational principle that children, or indeed adults, learn best when they are interested and when they have some stake in the outcome. Scientific principles are most readily grasped when their operation can be experienced first hand in simple experiments. Quantitative data is most illuminating when you have measured it yourself and helped draw conclusions. This argues for a strong component of experiment or demonstration, coupled to a teaching style that emphasises scientific methods and general principles. It is also important that children be actively involved in making and using simple equipment, measuring results, and analysing data.

These principles are useful only if they can be put into effect by busy and often inexperienced teachers dealing with quite large classes of ordinary children. This argues for carefully structured lesson materials, clearly defined and readily available equipment for experiments, and an extensive program of in-service training and assistance for teachers. The program must also be flexible enough that it does not inhibit the flair of excellent and well-prepared teachers.

Finally, the program as a whole is designed to stress the links between science, technology and the environment. Children should see scientific principles underlying common technologies, they should see biology at work in the environment, and they should appreciate the science and technology underlying the choices that have to be made for the future of humanity.

Primary Investigations

The present working title for the Academy materials is *Primary Investigations: Science, Technology, Environment.* While in principle we could have developed our own materiais from scratch, this would have involved immense time and effort. Instead, we were fortunate in being able to come to an arrangement with the US Biological Sciences Curriculum Study, which developed the text upon which was based our immensely successful *Web of Life*, to use materials that they have developed with the assistance of a large grant from the US National Science Foundation. Our royalty payments to the BSCS will be used, in part, to finance visits of some of their staff to Australia during latter stages of the project.

The original BSCS material had the title *Science for Life and Living* and covered science, technology and health. This combination is not appropriate in the Australian school context, and environment, with obvious Australian examples, will replace health, which is covered elsewhere in the primary school curriculum. The environment section in the Australian version is taken very broadly, and includes some geology and some astronomy, in agreement with the National Statement. The technology sections use the design/make/appraise approach and integrate closely with the science strands. There is a balance of attention between the processes of science and scientific knowledge itself.

The BSCS course is excellently integrated and does not, as one might fear from its origins, over-emphasise biology at the expense of physical sciences. The approach is rather one of integration so that, for example, conservation of energy is studied in class experiments with falling weights, spinning wheels and heating brakes, then applied to physical systems such as bicycles and their riders, or record players, and finally to photosynthesis and food energy chains in ecosystems. The emphasis is on understanding, rather than on a knowledge of formal statements.

Although some of the course is simply qualitative, there is a welcome strand of quantification, even in the biology - students do not simply watch plants grow, but measure their growth under different conditions and graph the results. There is similar attention to measurement and display of results in the physical sciences and technology.

The emphasis on class experiments is, of course, welcome, but one might well ask about practicality. In fact all the equipment used is readily obtainable - drinking straws, plastic cups, marbles, pieces of string, simple household chemicals, etc. - but collecting these for a class is a considerable burden. The program therefore proposes to supply these items on a whole-school basis in a way to be discussed in a later section.

Adapting the BSCS Materials

The decision to develop a program based on the BSCS materials was made only after extensive consultation with education authorities and curriculum specialists and a careful consideration of possible alternatives. A decision,to go ahead was made in July 1992 and Dr Denis Goodrum, on leave from his position as head of the School of Mathematics, Science and Technology Education at Edith Cowan University in Perth, was appointed Project Director. A project committee, with representatives from most states and an observer from New Zealand, gives general advice on the progress of the enterprise. A small writing team based in Perth is at present adapting the BSCS materials to meet our needs, and further ▷

editorial and layout work is then done by Academy staff in Canberra.

In adapting the BSCS materials to Australian needs we have had to make substantial changes quite apart from introducing the environment section. Many of the changes are cultural, because American backgrounds and emphases are rather different from those in Australia; some are practical, because the American materials are rather too "wordy" and the production makes them unduly expensive; some are to introduce examples and experiments more relevant in an Austraiian context.

The development stage of the project is being supported by generous funding from several sources. Total development costs, including trialling which will be discussed below, are estimated at about $600,000. Support has been received from the mining company CRA, the Department of Industry, Technology and Commerce through its Science and Technology Awareness program, the Department of Employment, Education and Training through its Projects of National Significance Program, and the Department of the Arts, Sport, the Environment and Territories. The Academy is underwriting the balance, though further grants will be sought. Total project costs will be approximately $3.5 million, with total income balancing expenditure after about ten years. Any profits after that time will go to fund revisions of the Primary Investigations program, further Academy educational programs, or both.

Program Design

The Academy program is unusual in that it does not simply aim to provide teaching materials for teachers or books for students to be adopted on a class-by-class basis. Rather it is a "whole school" program. This is important, because the course itself is integrated over the whole seven years of primary schooling, and each year reinforces or extends approaches and understandings of previous years. We see this as also having important practical advantages, because teachers at all levels in the school will be able to share insights and assist with problems as they arise. It will also, of course, help with the mobility of children from one school to another, although it would be over-optimistic to expect that more than about 25 percent of Australian schools would adopt the program in the next five to ten years.

Primary teachers try out a class experiment.

Some might see this approach as a constraint on those already teaching primary science confidently but, to be realistic, the number of such people is regrettably small. We believe, however, that the lessons and experiments have sufficient flexibility and a sufficiently open-ended nature that good teachers can modify them to meet their own wishes. Such teachers will also be able to make use of some of the excellent primary science experiments now becoming available through the National Science and Technology Centre and other groups. Such materials are complementary to, not competitive with, our program.

Trialling

Introduction of a new teaching program, even one that has been substantially trialled in another country, inevitably shows up particular problems. With this in mind, the Academy is undertaking an extensive trial of the program during 1993. To gain as much useful information as possible, this trial involves 38 schools chosen to have a variety of backgrounds, in Queensland, New South Wales, Victoria, South Australia, and Westem Australia. In each case the trial is on a whole-school basis, so that some 700 teachers and 12,000 children are involved. Every staff member in each of these schools has already attended a two-day in-service course on the program to cover the first term's work, and similar courses will be held for later terms. The Academy has supplied all the student and teacher books - one term at a time as they come from the project committee - together with kits for each class containing the experimental materials and equipment. Feedback from each teacher will be carefully considered and used in a further rewrite of the materials.

It is a measure of the need for a program such as this - and of the enthusiasm of primary teachers generaily - that more than 500 schools responded enthusiastically to our request for expressions of interest in participating in this trial, despite the rather onerous commitments involved.

Implementation

Our schedule proposes that the materials be published in September 1994, so that there will be adequate time to introduce them for the 1995 teaching year. This will involve an immense amount of work for all those involved, but it seems best to press on as rapidly as possible. The printed materials and equipment are, however, only part of the plan. Just as importantly, all teachers in schools adopting the program must be able to participate in appropriate in-service courses before the beginning of the year. Our trial this year is establishing just what is required, and arrangements are being put in place for the large training program that will be necessary in all states in the latter part of 1994. In this we will be assisted by the staff of the CSIRO Science Education Centres in each state, and by other arrangements.

In view of the whole-school aspect of the program, we also expect to use some innovative methods to provide the text books and other materials. While costs will be kept as low as ▷

possible, with direct distribution from the Academy rather than through book sellers or other agents, the expense for a typical school will still be considerable. We estimate this at $3,000 to $10,000, depending upon the size of the school, which includes continuing professionai development for all teachers in the school. Such a figure is, however, at just the sort of level that might be appropriate for a P&C association, a local Service Club, or a local supermarket or other business, in the same way that such groups have in the past supported things such as computers for schools. The teachers' resource books are all re-usable, as are the students' books and many of the materials, so that recurrent costs will be small.

Conclusion

Our strategy plan *Physics: A Vision for the Future* rightly remarks that primary school education is "the most vital component of our education system, but it is also the most readily ignored, and the most difficult to do anything about." I believe that the Academy's primary science, technology and environment program is an important and very appropriate reaction to the needs of Australian children and teachers in this important education sector. It is rightly directed towards the generality of teachers and the generality of children, for two reasons — attitudes to science, technology and the environment are formed early, and every informed citizen requires an appreciation of the general content and importance of these subjects; and we do not know which of those children will be attracted to become doctors, engineers or scientists themselves, for the future benefit of the community. ◆

IPRL ESTABLISHES INTERNATIONAL ROLE IN INTELLIGENT MATERIALS RESEARCH

Leading Role for Professor Gordon Wallace

Since the introduction of the intelligent materials concept in 1985 the Intelligent Polymers Research Laboratory (IPRL) at the University of Wollongong has been at the frontier of research activities in this area.

The growing acceptance of intelligent materials has seen IPRL play a more international role in recent years - a role that is destined to continue as IPRL forges collaborative research links with other research groups around the globe.

As part of IPRL's continuing contribution, Professor Gordon Wallace has been appointed Associate Editor of the "Journal of Intelligent Material Systems and Structures" and has been elected as Technical Chairman for the 2nd International Conference on Intelligent Materials to be held in the USA in 1994. In addition IPRL will host the 2nd Asia Pacific Workshop on intelligent Materials (Focus - The role of Polymers) in December 1993. A fascinating program has been organised and includes speakers from Europe, Japan and the USA and Australia (more details will be available later).

Following a successful Academy of Science sponsored visit to Japan in 1992 Professor Wallace has also established a Japan-USA-Australian collaborative project in the use of intelligent membranes for cell culturing. The project is sponsored by the US Army Research Office (Far East) and has recently attracted some supporting funds from DITAC. The project involves Professor Wallace and Dr Hodgson from IPRL, Professor Naoya Ogata and Dr Aoki from Sophie University (Tokyo), Dr I. Ahmed (US ARO - Far East) and Dr D. Kaplan (US Army Research Laboratories, Natick USA).

The establishment of international collaborative projects such as this is required to ensure major advances in intelligent materials in the near future.

For more information
Tel/business hours: (042) 21 3127
Fax: (042) 21 3114
Tel/Fax-After hours: (042) 26 1736