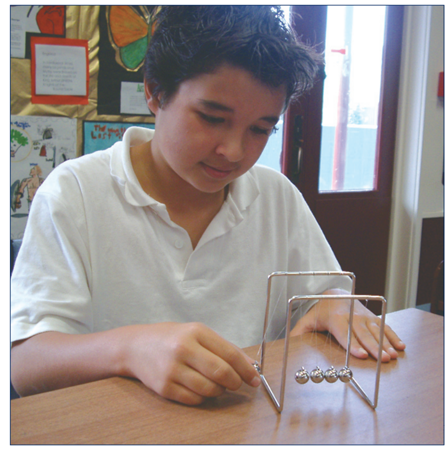

Science – a Universal Discipline

Science is an active process, drawing upon and contributing to a growing and changing body of knowledge. It is a universal discipline that involves using knowledge, understandings, skills and imagination to tackle problems and to investigate objects and events of the real world. A science education encourages students to have enquiring minds and to make sense of the actions and interactions of the biological and physical features of their environment.

Science and the National Curriculum

Science education represents part of a balanced curriculum for all New Zealand school students. The science curriculum is organised into four major areas of learning which are intended to help students make sense of the living world, the physical world, the material world, and planet Earth and beyond. Since science is both a process of enquiry and a body of knowledge, the curriculum also requires that students are helped to develop scientific ideas, skills and attitudes, and "acquire an understanding of the nature of science and its relationship to technology".

Within the major areas of content, the aims of a science education include the development of knowledge and understanding, skills of scientific investigation, and attitudes on which such investigation depends. Science is promoted as an activity that is carried out by people as part of their everyday life. Students are to be helped to "explore issues and to make responsible and considered decisions about the use of science and technology in the environment".

Framework for National Monitoring Assessment of Students' Knowledge, Skills and Attitudes in Science

NEMP task frameworks are developed by the Project's curriculum advisory panels. They have two key purposes: to provide a valuable guideline structure for the development and selection of tasks, and to bring into focus important dimensions of the learning domain that should be included in valid analyses of students' knowledge, skills and attitudes.

The frameworks are organising tools that interrelate main ideas, processes and attitudes with reference to important learning outcomes. They are intended to be flexible and broad enough to encourage and enable the development of tasks that lead to meaningful descriptions of what students know and can do.

The science framework has a central organising theme supported by three interrelated aspects. The **central organising theme**, "Science in everyday contexts", sets the broad context for tasks and is consistent with the aims of New Zealand's official science curriculum.

> *Learning in science is fundamental to understanding the world in which we live and work. It helps people to clarify ideas, to ask questions, to test explanations through measurement and observation, and to use their findings to establish the worth of an idea.*
>
> *(Science in the New Zealand Curriculum, 1993)*

The **content aspect** highlights four categories of subject matter for a science education.

The **approaches aspect** lists the kinds of scientific skills and attitudes that students could be expected to demonstrate in these subject matter areas. These overlap with skills and attitudes required in other learning areas.

The **motivation aspect** of the framework directs attention to the importance of having information about students' science interests, attitudes, confidence and involvement, both within and beyond the school setting. Educational research and practice confirm the impact of student motivation on achievement and learning outcomes.

SCIENCE ASSESSMENT FRAMEWORK

CENTRAL ORGANISING THEME

Science in everyday contexts

CONTENT ASPECT

LIVING WORLD

- **classification**
  whales are mammals
- **form and function**
  whales lungs take in oxygen
- **growth and change/life cycles**
  whales have live young
- **interdependence**
  plankton and whales are part of the same food chain

MATERIAL WORLD

- **properties**
  wax melts and burns
- **uses**
  wax is the fuel in candles
- **changes & reactions**
  molten wax goes solid on cooling
- **chemicals in the environment**
  petrol and diesel engines emit pollutants

PHYSICAL WORLD

- **explaining phenomena**
  objects make shadows by blocking off light
- **patterns and relationships**
  the closer the light source the bigger the shadow
- **explaining the use of physical phenomena in technological products**
  a sun dial shows the time by the position of the shadow

PLANET EARTH AND BEYOND

- **Earth**
  erosion by rivers is part of a natural process
- **geological history**
  ice ages had an effect on life and landscape
- **solar system**
  Earth's rotation causes day and night
- **guardianship of Earth**
  clearing the bush can harm wild life and increase erosion

NATURE OF SCIENCE

What science is and how you do it

(examples italicised)

APPROACHES ASPECT

ESSENTIAL SKILLS FOR SCIENCE

- using information and knowledge
- communicating: talking, writing, explaining
- enquiring, asking questions, investigating
- analysing, solving problems
- using equipment, tools and procedures
- scientific thinking: considering and arguing evidence

ESSENTIAL ATTITUDES FOR SCIENCE

- **scientific attitudes**
  interconnectedness of all things, open-mindedness, respect for evidence, considering and arguing evidence, persistence, honesty.
- **habits of mind**
  disposition to ask questions about the world around us and to undertake some exploration to answer the questions and draw conclusions.
- **ethical and cultural awareness**
  identifying and valuing different people's perspectives;
  science should be used in the interests of all people.

MOTIVATION ASPECT

Participation

Initiating scientific activities, choosing to take part, using scientific ways of working in everyday contexts.

Interest

Displaying curiosity, awe, enthusiasm.

The Choice of Science Tasks for National Monitoring

The choice of science tasks for national monitoring is guided by a number of educational and practical considerations. Uppermost in any decisions relating to the choice or administration of a task is the central consideration of validity and the effect that a whole range of decisions can have on this key attribute. Tasks are chosen because they provide a good representation of important dimensions of a science education, but also because they meet a number of requirements to do with their administration and presentation. For example:

- Each task with its associated materials needs to be structured to ensure a high level of consistency in the way it is presented by specially trained teacher administrators to students of wide-ranging backgrounds and abilities, and in diverse settings throughout New Zealand.
- Tasks need to span the expected range of capabilities of year 4 and 8 students and to allow the most able students to show the extent of their abilities while also giving the least able the opportunity to show what they can do.
- Materials for science tasks need to be sufficiently portable, economical, safe and within the handling capabilities of students. Visual items need to depict images and contexts that have meaning for students.

- The time needed for completing an individual task has to be balanced against the total time available for all of the assessment tasks, without denying students sufficient opportunity to demonstrate their capabilities.
- Each task needs to be capable of sustaining the attention and effort of students if they are to produce responses that truly indicate what they know and can do. Since neither the student nor the school receives immediate or specific feedback on performance, the motivational potential of the assessment is critical.
- Tasks need to avoid unnecessary bias on the grounds of gender, culture or social background while accepting that it is appropriate to have tasks that reflect the interests of particular groups within the community.

National Monitoring Science Assessment Tasks

Sixty-six science tasks were administered, using three different approaches. Thirty-eight tasks were administered in one-to-one interview settings, where students used materials and visual information. Nine tasks were presented in team situations involving small groups of students working together. Nineteen tasks were attempted in a stations arrangement, where each student worked independently on a series of paper-and-pencil tasks, many of which included the use of hands-on materials or visual information.

Fifty-two of the 66 tasks were the same or substantially the same for both year 4 and 8, while five tasks were unique to year 4 and nine tasks unique to year 8.

Trend Tasks

Twenty-five of the tasks in this report were previously used in identical form in the 1999 assessments. These were called *link tasks* in the 1999 report, but were not described in detail to avoid any distortions in 2003 results that might have occurred if the tasks had been widely available for use in schools since 1999. In the current report, these tasks are called *trend tasks* and are used to examine trends in student performance: whether they have improved, stayed constant or declined over the four-year period since the 1999 assessments.

Link Tasks

To allow comparisons of performance between the 2003 and 2007 assessments, 29 of the tasks used for the first time in 2003 have been designated *link tasks*. Student performance data on these tasks are presented in this report, but the tasks are described only in general terms because they will be used again in 2007.

National Monitoring Science Survey

Additional to the assessment tasks, students completed a questionnaire that investigated their interests, attitudes and involvement in science activity.

Marking Methods

The students' responses were assessed using specially designed marking procedures. The criteria used had been developed in advance by Project staff, but were sometimes modified as a result of issues raised during the marking. Tasks that required marker judgement and were common to year 4 and year 8 were intermingled during marking sessions, with the goal of ensuring that the same scoring standards and procedures were used for both.

Task by Task Reporting

National monitoring assessment is reported task by task so that results can be understood in relation to what the students were asked to do.

Access Tasks

Teachers and principals have expressed considerable interest in access to NEMP task materials and marking instructions, so that they can use them within their own schools. Some are interested in comparing the performance of their own students to national results on some aspects of the curriculum, while others want to use tasks as models of good practice. Some would like to modify tasks to suit their own purposes, while others want to follow the original procedures as closely as possible. There is obvious merit in making available carefully developed tasks that are seen to be highly valid and useful for assessing student learning.

Some of the tasks in this report cannot be made available in this way. Link tasks must be saved for use in four-years' time, and other tasks use copyright or expensive resources that cannot be duplicated by NEMP and provided economically to schools. There are also limitations on how precisely a school's administration and marking of tasks can mirror the ways that they are administered and marked by the Project. Nevertheless, a substantial number of tasks are suitable to duplicate for teachers and schools. In this report, these access tasks are identified with the symbol above, and can be purchased in a kit from the New Zealand Council for Educational Research (P.O. Box 3237, Wellington 6000, New Zealand).

Teachers are also encouraged to use the NEMP web site (*http://nemp.otago.ac.nz*) to view video clips and listen to audio material associated with some of the tasks.