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ABSTRACT

The results of the Third International Mathematics and Science Study (TIMSS) published in 1977 suggested that the achievement of New Zealand students in science could be considerably improved. A significant barrier to improving achievement, particularly in the physical sciences, was identified as a lack of teacher knowledge of the scientific concepts needed to implement a meaningful program of learning. The production of hands-on material for teachers to use in the classroom that translated the ideas and requirements of the curriculum into practical activities was recognized as a high priority. In addition, the material needed to identify the scientific background necessary for teachers so that they could support students in their science learning. This paper documents the writing of two resources, "Making Better Sense of the Material World" and "Making Better Sense of the Physical World", and discusses the reasons behind their format, structure, and the involvement of practicing teachers in their development. (SAH)

# Helping Primary School Students Make Better Sense Of The Material And Physical Worlds

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## Introduction

The results of the Third International Mathematics and Science Study (TIMSS), published in 1997, suggested that the achievements of New Zealand students in science could be considerably improved. A significant barrier to improving achievement particularly in the physical sciences was identified as a lack of teacher knowledge of the scientific concepts needed to implement a meaningful programme of learning.

The production of hands-on material for teachers to use in the classroom that translated the ideals and requirements of the curriculum into practical activities was recognised as a high priority. In addition the material needed to identify the scientific background necessary for teachers so they could support students in their science learning. This paper documents the writing of two resources; Making Better Sense of the Material World and Making Better Sense of the Physical World and discusses the reasons for their format, structure and the involvement of practicing teachers in their development.

## Background

Major curriculum reforms have taken place in New Zealand over the last ten years with new curriculum statements replacing the previous national curriculum. The New Zealand Curriculum is the Government's official policy for teaching, learning and assessment for New Zealand state schools. This policy is set out in the 1993 document entitled The New Zealand Curriculum Framework, the national curriculum statements and in other supporting documents. Science in the New Zealand Curriculum is one of the seven documents which describe in broad terms the knowledge and understanding of the essential learning areas.

The New Zealand Curriculum Framework outlines the principles which should underpin all teaching and learning in New Zealand state schools. It identifies the seven essential learning areas; eight sets of essential skills to be developed by students; the place of attitudes and values in the curriculum; and the policy for assessment at school and national level.

The detail of the New Zealand Curriculum is provided through the national curriculum statements. These specify the knowledge, skills, attitudes and values to be developed through each of the essential learning areas. National curriculum statements also specify broad learning outcomes, achievement aims for different strands of the syllabus, and objectives at different levels of learning. They are intended to provide guidelines to assist teachers to develop learning programmes for students that meet the requirements of the New Zealand Curriculum. They are, however, also intended to be broad and flexible enough to allow for local interpretation and implementation.

This broadness and flexibility has created particular problems for generalist primary teachers (year 1 – 8) as documented in a report released in 1996 by the Education Review Office, titled Science in Schools. Implementing the 1995 Science Curriculum. (The Education Review Office is the

government department responsible for evaluating and reporting on education in all schools, early childhood centres, and all other forms of pre-tertiary education.)

Three major issues emerged from the above report:

- The science curriculum statement
- Delivering the planned curriculum
- Expertise in teaching science

- The science curriculum document conceptually provides a challenge for teachers, especially those with little background knowledge of science (page 21).
- In most cases poor curriculum delivery would result from lack of confidence with the subject matter or the teaching or assessment approach (page 22).
- One of the most significant barriers to the successful implementation of Science in the New Zealand Curriculum is teacher expertise and confidence. Some teachers, particularly in primary schools, are not yet sufficiently trained in the science curriculum and have an incomplete understanding of it. These teachers find it difficult to cope with the content, planning, implementation or assessment demands of the curriculum (page 22).

## Philosophy and Goals for the resource

As a result of the above report the Ministry of Education advertised for registrations of interest to develop curriculum materials for teachers of years 1 to 8 students, to assist in the implementation of the curriculum. In addition the materials needed to be designed to support non- confident teachers of science and address the lack of science knowledge of generalist teachers. On behalf of the School of Education, University of Waikato I submitted a proposal which was accepted and a contract was signed initially for the resource to address the Material World or chemistry strand. The contract was later modified to include the Physical World or physics strand. My position as principal writer and director of the project involved facilitating the writing team and conducting the final reworking, polishing and compilation of the manuscript.

In consultation with experienced teachers and specialist educators a format for the resources was developed with the following features:

- ✓ Science focuses that are relevant, meaningful and attractive to students and teachers and have strong links with everyday events.
- ✓ Coverage of the achievement objectives at the appropriate level.
- ✓ Identified links with other curriculum areas to assist with management and coverage of a perceived overcrowded curriculum.
- ✓ Supportive to non-confident teachers of science as well as offering challenges to more able teachers of science, with ideas for extension activities to further develop the focus.
- ✓ Each activity having the following components:
  - ✤ Achievement objectives identified

- ✤ Possible specific learning outcomes listed
- ✤ Assessment tasks outlined
- ✤ Ideas for curriculum integration

✓ Each focus area to include teacher's notes, background scientific knowledge written in everyday language, references, samples of students' work and photographs.

The resources aim to assist classroom teachers to fulfill the requirements of the science curriculum in a way that can be adapted and extended as teacher and student knowledge and confidence grows. It is important to acknowledge that the needs of individual teachers and students are different and can change over time.

In summary the resources were to consist of a series of science focuses that link the science concepts inherent in the achievement objectives with specific activities.

## The Project

The writing team consisted of 11 practising teachers from a wide range of teaching situations; rural, city, small town schools and covered all the levels from year 1 to 8. The criteria for inclusion on the team was to have a strong interest in teaching science and to be open to new ideas, be prepared to take risks and willing to try out new ideas.

This team met for five days during the project and they were also visited in their schools twice. In addition on-going contact was maintained for support and to answer any queries and concerns. There was a need to up-skill the team in the science knowledge and this was addressed in a workshop situation where the science concepts were explored and the ideas discussed and clarified. It was necessary to describe the knowledge base for the team because with the exception of one teacher the remainder of the group had limited science background. It was felt that the objectives of the resources would be more likely to be met when the material was developed by experienced competent teachers rather than using science specialists who would not necessarily appreciate the barriers that non-specialist teachers experience.

The team developed teaching sequences appropriate for their level, trialled these in their classrooms and modified and reworked them in consultation with the rest of the team. As the project developed it became apparent that each science focus had several Big Ideas that provided the framework for the teaching of the focus, these were linked to the embedded science ideas or the major science concepts for the strand.

The embedded science ideas or concepts for the Material World Strand were:

Physical and Chemical Properties
Changes of State
Rates of Reaction

The embedded science idea or concept for the Physical World Strand was:

When forces do work, energy changes from one form to another.

## Third International Mathematics and Science Study (TIMSS)

Meanwhile the report of the above study was released and as result the Minister of Education established the Mathematics and Science Task force to provide advice as to the kind and level of support that classroom teachers needed to make the curriculum reforms in mathematics and science work. The Task force was established because of the reported difficulties of classroom teachers (especially primary teachers) in implementing the new curricula for mathematics and science and in the light of the reported results of the Third International Mathematics and Science Study.

- The following recommendations were made by the Mathematics and Science Task force
- In science there is a priority need for materials that reflect Science in the New Zealand Curriculum, have explicit science concepts that are evident to both teachers and students, and that provide teachers with science background.
- Teachers need help to identify the particular scientific ideas that students could learn within a context.
- The task force felt that developing materials should be trialed by a range of 'ordinary' teachers, using a range of different teaching styles, in a range of different settings.
- Current issues provide many opportunities for teaching science but teachers need access to current scientific knowledge in such areas.

The resources under development fitted in extremely well with the recommendations made by the taskforce and they have since been involved in reviewing both the manuscripts.

## Final Format of the Resources

The format of each resource has been slightly different to accommodate the nature of the strands. For example in the Material World book each chapter had a science focus with a series of identified Big Ideas. These Big Ideas were explained by a series of general notes and then each Big Idea was associated with a series of activities. Whereas, in the Physical World book the science focus could be approached from several directions. For example Light and Colour could be broken up into subsections on mirrors, shadows, magnifiers, bubbles, rainbows and colour spinners. Although there were general notes associated with the main science focus. Each sub section also had its associated Big Ideas and specific notes. It is not intended that the entire chapter is taught at once but rather that teachers focus on a particular section at any one time.

The resources also had other common features such as: (OHT examples from both books)

An introductory chapter which included:

- An explanation of the format of the book
- A chart explaining the meaning of the objectives
- A section on planning
- A section on investigating skills in science

A Science Concept chapter which included:

- An explanation of the science inherent in the strand

Each science focus chapter included:

- The Big Ideas

- General notes
- Activities set out in a common format and designed to be photocopied and used by students. Each activity listed the equipment in What You Need and instructions to carry out the activity in What You Do.

## Future Directions

The activity sections of both books are available for downloading off the Internet at: (address)

- Two more books are being developed to provide support material for all four strands. Making Better Sense of Planet Earth and Beyond is with the publishers and is due for release in early November.
- Making Better Sense of the Living World is under development with the main thrust to make the Living World more interesting for primary students and get way from 'doing Rock Pools" and having a Nature Table in the classroom.
- Professional Development Programmes have been in place nationwide during terms one and two this year to familiarize teachers with the resource, and support them as they implement the ideas in their classrooms.
- A contract has just been signed to develop two more resources to cover the integrating strands: Developing Scientific Skills and Attitudes and Making Sense of the Nature of Science and its Relationship to Technology. These two resources will focus on Investigating in Science and The Nature of Science.

## Reflections

The project has and continues to be exciting and challenging with a few battles mostly won. I feel we have developed some really user-friendly resources to help and support teachers as they implement a classroom programme in science.

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