A MODEL FOR DESIGNING SKILLS-ORIENTED PRIMARY SCIENCE MATERIALS

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Introduction

The full paper will describe the development, by the *Science For All Project*, of innovative science learning and teaching materials for Grades 4 to 6 (Stds.2 - 4), using a model of instruction designed by the Threshold Project (Macdonald, 1990).

The Threshold Project researched the teaching and learning patterns in ESL primary classrooms from 1985 to 1991, and paid particular attention to science lessons. The Threshold reports analyze the predominant mediation strategies used by teachers who must explain difficult concepts to pupils in a second language, and see the classroom interaction of these teachers being constrained by a paradigm of *the one-who-knows showing the-one-who-does-not-know*. The Threshold Project contrasts that rote-learning model of instruction with the idealised pupil-centred generative model (Harlen and Osborne, 1985) but acknowledges the latter model's problems with coverage, mastery and management. Threshold then proposes a transitional model with characteristics which would support pupils in more autonomous problem-solving behaviour, while still retaining the teacher's central influence in lessons.

The development approach adopted by the Science For All Project deals pragmatically with some severe constraints on research and trialling, and has the potential for professional development of teachers participating in the process.

The design of the materials

The design of the *Science For All* materials, drawn up in 1995, was greatly influenced by the decision of the NETF, in 1994, to introduce science immediately as a subject in Std.2 (Grade 4) in all ex-DET schools. The NETF policy decision took it for granted that the medium of instruction (MoI) would be English, despite the fact that officially the MoI is mother-tongue in Std.2. A further influence on the design was the Threshold Project's analysis of the severe difficulties of meaningful instruction in science in Std.3 where the MoI changes to English.

However, the development reference group, which included the commissioning editor and staff of the Primary Science Programme, were unanimous that the materials should be directed toward the ideal of the autonomous, skilled problem-solving learner, rather than toward the presentation and transmission of subject content. The project reference group was influenced by the finding of the Threshold Project that Std.3 pupils were able to reason, *in their mother tongue*, far more effectively about a science topic than would be thought from hearing or reading them answering questions in English (the MoI). More than this, conventional teaching and testing was under-predicting their intellectual abilities. To correct this under-stimulation and under-estimation of the children, the teacher must have suitable higher-quality tasks immediately available to

her in the materials, but be encouraged to allow the children to use their most fluent languages.

For these and other reasons, the *Science For All* Project adopted the transitional instruction model for science, briefly described above. The full paper will set out the characteristics of the transitional model, and explain how they were interpreted for this project. Flowing from the model, the materials for teachers and pupils show certain regular features:

1. They emphasise the development of communicative and expressive skills through the activities and questions embodied in the materials, both in group-work and individual work
2. They emphasise the use of process skills such as description, drawing and other forms of recording, comparison and classification, interpretation and transformation of information, inference-making and idea-testing.
3. The first lesson in each chapter stresses the need to elicit pupils' initial ideas about a topic in free-ranging discussion; such discussion should alow the use of the pupils' most fluent languages, moving only later to the introduction of new English words. One aim of such activities is to build pupils' confidence in their own abilities to grapple with new concepts, and another aim is to inform the teacher about the sorts of ideas at large in the class. Some of these ideas might be fruitful starting points for the teacher to build upon, while other ideas might be misconceptions which will influence the pupil's understanding of all the work which is done in the rest of the chapter.
4. The assessment units usually contain a mix of types of questions: some will appear familiar to the teacher as recall questions, while others reinforce the use of skills such as interpretation and are the open-book type.

Aspects of the materials which we expect will favour adoption of some of the innovations

At the time of writing, we are collecting data on the fit between the approach and the practice of teachers in a trial school. However, it seems that teachers will find the following aspects attractive:

1. The materials support skills-development, learning outcomes and performance assessment, which fortunately has become official policy since the books were first designed;
2. Teachers will receive the **teachers' editions** of the books, which contain in-text answers, overprinted on the pupil text, additional information in footnotes and fairly extensive methodological and information text in the front section
3. Pupils may find that the comic characters in the text create continuity and context for the unfolding science concepts.

Classroom factors which might counteract adoption of the innovations

1. Many teachers teach orally and with little use of resource materials such as textbooks; they use rather limited mediation skills, such as

checking that information has been heard or can be recited, and thus may not respond to the more varied activity required of the children when using the materials.

2. There is a view among teachers that "high standards" in a textbook can be seen in **extensive factual information** in the book; this might contrast unfavourably with the project view that textbooks should contain many **high-quality tasks** for pupils, requiring the development of various skills
3. The materials imply the need to find, store and manage the use of equipment for pupils' activities; this aspect has proved to be the downfall of other innovation programmes
4. Certain questions in the materials are open-ended, having several possible answers

The problem of innovation in traditional classrooms

The reference group adopted a development plan (to be described in another paper) which kept the writers conscious of the limits of innovation that teachers will accept. The group drew on a good deal of literature and personal experience of attempting innovation programmes in schools, and the writers designed into the text certain aspects which consciously acknowledge traditional classroom strategies. However, none of the group is under the illusion that innovative materials in themselves can bring about deep-rooted change in teachers' understanding of the purpose of their interaction with children. Our modest hope is that as teachers become familiar with the materials, they will be influenced to ask questions which require more problem-solving behaviour from children.

The design of these skills-based materials has been affirmed by the 1996 decision of the Department of National Education to institute a curriculum policy of Outcomes-Based Education (OBE). However, it is a real question whether the OBE innovation is so far out of touch with the imperatives of the traditional classroom that it cannot be implemented in its envisaged form. The *Science For All* innovation, based as it is on a transitional model of instruction, may prove to be the most practicable first step towards the complex OBE ideals in primary science classrooms.