PROGRESSION IN LEARNING SCIENCE

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ABSTRACT
A national curriculum comprising statements of attainment at different levels must be underpinned by some idea of "progression" in learning. Questions arise as to the nature and meaning of progression. To gain a deeper insight into how children progress in their understanding of science, this research involves the construction and testing of a hypothetical learning sequence for the topic of forces. This interim report explains how children aged 7 to 13 are being interviewed to explore their explanations of phenomena involving forces. These explanations will be mapped onto the sequence to provide a multi-dimensional model of progression.

INTRODUCTION
In the national curriculum for England and Wales, each subject is specified in terms of a few main target areas, each covering the whole range of compulsory schooling from ages 5 to 16. All target areas are specified by criterion statements set in a sequence of ten levels, level two comprising criteria appropriate for the average 7 - year old, level three for a 9 - year old, and so on. This system follows a recommendation (DES, 1988) that the curriculum should promote a criterion referenced approach which would support formative assessment and serve as a guide to the progression in learning of each child. Pupils would be expected to progress at different rates through the ten levels.

This scheme requires that the criterion statements are grouped in appropriate levels and ordered in an appropriate sequence. Whilst those writing the curriculum have done this as best they can, this demand gives rise to fundamental questions about progression in learning and about the effects of teaching on such progression. As Driver (1989) points out, studies of students' conceptions present us with discrete snapshots in the continual construction and reconstruction of students' knowledge. Although such studies provide valuable insights that can inform curriculum planning and the possible sequencing of ideas for teaching purposes, they do not provide information on the dynamics of change, information that is necessary as a basis for understanding progression, and designing curricula in a progression framework.

This paper reports on the first stage of a two-year project which aims to study progression in children's learning of two topics. Of these two, measurement and forces, only the second will be discussed. The discussion is based on preliminary findings and concentrates on describing theoretical and methodological issues.

DESIGN OF THE STUDY
The data for the study are being collected by individual interviews, each interview being based on phenomena shown to the child with simple equipment. Children at ages 7, 9, 11 and 13 were selected, with six pupils chosen from each of three schools at each age. It is intended that each of these seventy-two children will be interviewed on two
occasions, about three months apart, so chosen that teaching relevant to the interview topics will have taken place between the two occasions. There has been no attempt to do other than observe this teaching as carried out by each teacher in his or her normal way. The interview structure and the equipment and effects to be used were developed and refined through pilot studies. At the time of writing, most of the interviews for the first of the two main occasions have been completed, but the analysis of the interview transcripts is only just beginning.

Looking for progression in learning
The basis for the approach may be explained by a pictorial metaphor (see Figure 1). There are two countries, the science country inhabited by scientists and science teachers, and the pupils' country. The ways of thinking and the ideas used in these two countries are very different. The task of a research may be seen as an exploration of both countries which might lead to a comparison between the two and so to a study of ways of crossing the bridge. What constitutes crossing the bridge will differ according to the theoretical perspective employed.

Moreover, any research faces the methodological problem of deciding the basis on which its exploratory tools are to be constructed. The simplest way is to use the schemas of science to guide the construction of these tools. This has the advantage that the information gained will be directly related to the aims of the teaching, but the disadvantage that the pupils' world is being seen only through the selective, and possibly distorting spectacles, of the science country. Most research studies of alternative conceptions adopt this approach, although the research reports rarely discuss the rationale underlying the selection and composition of the research instruments used.

A second approach is to treat the pupils' country as a separate world to be explored on its own terms. This is attractive because it might give a more authentic view of the problem of constructing the bridge. However it is much harder to do because there is no obvious way of starting if one wishes to avoid causing bias in the data by using pre-conceived views. The proposal of the "naive physics manifesto" by Hayes (1979), and the work of Bliss, Ogborn and Whitelock (1989) on "common sense understanding" are examples of a direct approach of this type. Others have made more general proposals about the nature of the thinking peculiar to the pupils' world. Examples are Andersson's "experiential gestalt of causation" (1986), Carey's accounts of the nature of children's theorising (1989), Claxton's mini-theories (1991), Di Sessa's p-prims (1983) and Solomon's (1983) concept of a "life-world" separate from the "science-world".

![Fig. 1 The pupils' country and the science country](image-url)