ABSTRACT. A series of studies were carried out into the development of number concepts in 7–9 year old low attaining pupils. The aims of the work were:

(i) To identify a framework which describes children's orders of acquisition of number concepts.

(ii) To develop a diagnostic assessment instrument capable of describing children's understanding of number

(iii) To devise, carry out and evaluate teaching and activities which would extend the children's understanding of number.

Achievement of the first two aims is described in an earlier paper (Denvir and Brown, 1986a). The present paper describes how the third aim was achieved in two teaching studies. Both were based on the descriptive framework and children's performances in the diagnostic assessment interview. However the two studies differed in approach. In the pilot study pupils were taught individually and specific teaching points were selected for each child. In contrast to this, children who participated in the main study were taught as part of a group whose members had reached a similar level of understanding but had acquired slightly different skills. Consequently the focus was less on teaching specific points and more on linking different aspects of certain concepts.

In both studies the pupil's performances improved between pre and post tests, suggesting that the framework and the pupils' performances in the diagnostic assessment interviews may provide a useful basis for designing a remedial teaching programme.

BACKGROUND

The rationale for this study arose during the Schools Council Project 'Low Attainers in Mathematics 5–16' (Denvir et al., 1982) in which discussions with teachers revealed the need for diagnostic assessment linked to prescriptive teaching. An earlier paper (Denvir and Brown, 1986a) sets out the framework that was found for describing children's acquisition of number concepts and the diagnostic assessment instrument that was developed. In order to use these in planning and carrying out a remedial teaching programme it is necessary to consider what is known about how children learn.

Briefly, the model of learning adopted might be termed an 'Ausbubelian, skill-integrationist' approach. Following Piaget (1952) individuals are seen to learn as a result of their physical actions on the environment and their mental actions relating to these experiences. They are thought to integrate skills which they have already acquired when these are simultaneously called in to play in their mental actions, (Schaeffer et al., 1974). Consequently a suitable starting point for the design of activities for a particular learner is 'what the learner already knows' (Ausbubel et al., 1978).
The view is also taken that perceiving the 'equivalence of different intellectual strategies' (Bryant, 1982) is likely to lead to an association between mental skills which could result in integration of these skills, a notion that is supported by Lawler's (1981) work.

The model of learning which is adopted has several important implications for teaching:

(1) Children must be active, both in interacting with the physical world and in reflecting on these interactions.

(2) Ideas and materials presented must be related to what children already know, both to the types of reasoning available, i.e., their type of cognitive structure, and to their previous experiences, i.e., their frameworks of knowledge, in order to achieve Ausubel's (1978) 'meaningful learning' and Skemp's (1976) 'relational understanding'.

(3) In order to achieve integration of skills whereby new skills are developed, there will need to be repetition of the mental process involved in appropriate tasks.

(4) In order to acquire mathematical concepts, children will need, as Dienes (1960) suggested, a variety of examples of those concepts in different mathematical forms, different contexts and, possibly, in different modes.

(5) It is likely that as Bryant (1982) and Lawler (1981) suggest, children learn when different intellectual strategies turn out to produce the same result, especially if, in Lawler's words 'none was anticipated'.

AIMS

The aims of the two teaching studies were to:

(1) Gain insight into the learning of number in 7–9 year old low attainers and its relationship to teaching.

(2) Investigate progress in the development of number concepts made by low attainers during the period of the teaching study.

(3) Evaluate the usefulness of the hierarchical framework, described more fully in an earlier paper (Denvir and Brown, 1986a) for designing a remedial teaching programme.

The two studies were substantially different because results from the pilot teaching study led to a modification in the approach adopted for the main study. Each is described separately below.

PILOT STUDY

Organisation and Sample

The pilot study was carried out over a three month period with seven pupils