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TASK ANALYSIS IN CURRICULUM DESIGN: A HIERARCHICALLY SEQUENCED INTRODUCTORY MATHEMATICS CURRICULUM[1]

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A method of systematic task analysis is applied to the problem of designing a sequence of learning objectives that will provide an optimal match for the child's natural sequence of acquisition of mathematical skills and concepts. The authors begin by proposing an operational definition of the number concept in the form of a set of behaviors which, taken together, permit the inference that the child has an abstract concept of "number". These are the "objectives" of the curriculum. Each behavior in the defining set is then subjected to an analysis that identifies hypothesized components of skilled performance and prerequisites for learning these components. On the basis of these analyses, specific sequences of learning objectives are proposed. The proposed sequences are hypothesized to be those that will best facilitate learning, by maximizing transfer from earlier to later objectives. Relevant literature on early learning and cognitive development is considered in conjunction with the analyses and the resulting sequences. The paper concludes with a discussion of the ways in which the curriculum can be implemented and studied in schools. Examples of data on individual children are presented, and the use of such data for improving the curriculum itself, as well as for examining the effects of other treatment variables, is considered.

The curriculum presented in this paper is an intermediate result of a research program exploring application of detailed task-analysis procedures to the problem of designing sequences of learning objectives. The aim of this research program is to develop a systematic method of specifying and validating learning hierarchies so that instructional programs can be designed that provide an optimal match for a child's natural sequence of acquisition. It is assumed that curricula that closely parallel this sequence will facilitate learning under a wide variety of specific teaching methods.

The basic rationale for the methods employed here has been presented in papers by Resnick (1967) and by Resnick and Wang (1969). Briefly, the strategy is to develop hierarchies of learning objectives such that mastery of objectives lower in the hierarchy (simpler tasks) facilitates learning of higher objectives (more complex tasks), and ability to perform higher-level tasks reliably predicts ability to perform lower-level tasks. This involves a process of task analysis in which specific behavioral components are identified and prerequisites for each of these determined (*cf.* Gagne, 1962, 1968). Detailed procedures of analysis are explicated in the course of this paper.

An introductory mathematics curriculum must present the fundamental concepts of mathematics, or operations leading to them, in forms simple enough to be learned by very young children. Methodologically, this requires that target concepts be identified, and that hierarchies of specific objectives then be constructed to guide the child from naivete to competence in understanding and using these concepts. Finally, empirical studies, both laboratory and classroom, must be undertaken to validate the sequences of objectives and study the functioning of the curriculum in an applied setting. The first two sections of this paper deal with the problems of defining and analyzing early math-

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