Structural Learning and Open Education

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This article is based on two main theses: One, qualitative improvements in education will not come about as a result of rhetoric or superficial proposals for solution, but rather as a result of a deeper understanding of the teaching-learning process and the development and use of new and better principles of educational design; and two, theoretical bases already exist and should be used more widely by educators.

During the 1960s, educational technology began to evolve as a discipline in its own right, and "operational objectives," "prerequisites," "hierarchies," "mastery (criterion-referenced) testing," etc., became topics of discussion. Such concepts and techniques have been acclaimed by many educators and widely used in curriculum construction. They also have been the subject of a good deal of criticism. The most valuable educational objectives cannot be operationalized, some people have said. Others point out that the approach leads to fragmented curricula.

It is my contention that these criticisms, while partially justifiable, are not inherent in structural approaches to education. Unfortunately, the activism of the late 1960s resulted in a shift of interest from educational technology to the more social and "humanistic" aspects of educational reform. The recommendations made during this period ranged from well-intentioned warnings that education cannot take place in a social vacuum, to high-sounding rhetoric and simplistic solutions that have no scientific validity.

Largely unnoticed during this period were a number of important developments in such fields as formal linguistics, artificial intelligence, logic and mathematical foundations, information processing psychology, rule learning, and some fundamental work in educational design. Fortunately, the relevance to educational design and curriculum development of recent work in structural learning is being increasingly well-recognized. Implications of this work also extend to such "nonstructured" areas as critical reading based on logical inference. Instructional and test materials have been developed which can be used to pinpoint relevant capabilities of individual students, and to provide the exact instruction that each student needs to overcome his inadequacies.

Let us look at some of the more immediately relevant portions of the theory of structural learning. Over the past decade this research has gone through several phases. My initial efforts had the rather optimistic goal of understanding the teaching-learning process in its full complexity. I need not tell you that these efforts were something less than a complete success.

The second phase was spent trying to get a better handle on the problems involved, including the development of suitable research paradigms. This research consisted of a large number of individual studies ranging over a wide variety of phenomena involving complex human learning. A major theme of this research was that rules provide a more appropriate basis for analyzing complex human learning than do associations.

Levels of Theorizing

The fundamental notion of representing knowledge in terms of rules (procedures), together with the introduction of a few other equally basic assumptions, has provided the basis for a new comprehensive theory of structural learning which consists of three distinct but complementary levels of theorizing, each with its own type of empiricism. The first level is concerned with competence—how to account for the potentially observable behavior of interest to an "observer." Competence consists of a finite set of rules together with laws governing the way these rules may interact to account for behavior. What is new is the idea of allowing rules to operate in a higher-order fashion—to operate on and to generate new rules. Individuals do not have to be taught explicitly every rule that might be desired; much of their knowledge can be derived, when needed, from other information which is explicitly available.

The second level of the theory is obtained by adding more structure to the first, and deals with behavior under certain idealized conditions. This level is concerned with questions of performance, learning, motivation, and perception, in situations where the subject is not hampered by memory or his limited capacity for processing information. It does two things: It provides a basis for operationally defining the knowledge had by individual subjects, and it deals with the question of how and why available knowledge is put to use and how it is acquired in the first place. All learning is considered to be a problem-solving process.

The unrestricted third level of the theory deals also with memory and the limited capacity of subjects to process information. Although the main effort has been on theory development, some substantial
beginnings also have been made in developing practical implications for curriculum development and instructional planning.

During the past four years an increasing amount of empirical support for the theory has been obtained. We have found that it is both theoretically possible and practicable to determine the knowledge had by individuals, including higher-order capabilities; that the problem-solving mechanism proposed provides an adequate basis for explaining problem-solving performance and learning under the idealized conditions tested; that the higher-order rules method of analysis apparently can be applied to relatively complex mathematical subject matters such as geometry; and that one can “cut corners” and still use the method successfully in broad-based curriculum construction.

How does the structural learning theory provide a basis for conceptualizing the teaching-learning process? In outline form, the idea is that the learner has certain knowledge (rule sets) on entering the teaching situation. Additional learning takes place by interacting with the teaching environment. What is learned at each stage depends on what is presented to the learner and what he knows. The changes from stage to stage are cumulative.

To talk about the optimization of instruction, two additional ideas must be considered: We must be able to characterize the educational objectives to be achieved, and assign values to them. (Let us think of them as behavioral objectives with the proviso that objectives corresponding to higher-order rules are included.) Second, we must consider the various costs of instruction. The optimization of instruction, then, consists of finding an optimal trade-off between the sum of the values of the objectives to be achieved and the total time required for instruction—a type of cost-benefit analysis.

How do the values assigned to possible objectives associated with a given curriculum and the costs assigned to instruction provide a basis for tailoring curriculums to needs and circumstances? A basic problem of curriculum planning is to assign values to the various possible objectives, and costs to various kinds of instruction. Insofar as assigning values to objectives, the possibilities range from giving high value to relatively few objectives with low value to others, to moderate value over a broad range of objectives. Instructional time costs are similarly represented.

There are two points central to my main thesis. One, the efficiency of various types of curriculums depends on the values assigned to possible educational objectives and the costs (or availability) of various kinds of instruction. Two, any type of curriculum, including the open classroom, may be conceptualized in terms of an underlying theory of structural learning.