THE STRUCTURE OF SUBJECT MATTER CONTENT AND ITS INSTRUCTIONAL DESIGN IMPLICATIONS

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ABSTRACT

This paper discusses the analysis of subject matter structure for purposes of designing instruction. The underlying assumption is that subject matter structures provide an important basis for deciding how to sequence and synthesize the "modules" of a subject matter area. Four types of fundamental structures are briefly described and illustrated: the learning hierarchy, the procedural hierarchy, the taxonomy, and the model. Then a theoretical framework is presented for classifying types of subject matter content—both "modules" and structures. Finally, some implications of these content classifications are discussed. The classification of "modules" is hypothesized to be valuable for prescribing strategies for the presentation of single "modules", and the classification of structures is hypothesized to be valuable for prescribing strategies for selecting, sequencing, synthesizing, and summarizing related "modules". The need to take into account more than one kind of structure in the process of instructional design is emphasized.

Subject matter structure refers to the interrelationships among the components [1] of a subject matter. The structure of subject matter can be, and has been, analyzed for a variety of purposes. This paper discusses the analysis of subject matter structure for the purpose of designing instruction—textbooks, courses, workbooks, etc. The underlying motivation for this analysis is our belief that subject matter structures have important implications for the best ways to sequence (i.e., order) and to synthesize (i.e., show the interrelationships among) related components of a subject matter.

Our work in instructional strategies has led us to the conclusion that "structural" strategies such as synthesizers (i.e., explicit descriptions of types of pervasive relations among subject matter components) can have a far greater impact on instructional outcomes than the vast majority of instructional strategy variables that have been investigated to date. The purpose of this paper is to identify and describe some of those aspects of subject matter structure which may have the most prescriptive power for the development of, and the selection of, optimal structural strategies (e.g., the selection, sequencing, synthesizing, and summarizing of related components of a subject matter).
Instructional scientists and designers have long recognized the importance of analyzing subject matter structure for purposes of designing instruction. For several years, instructional designers have been using (or have claimed to be using) content and task analysis procedures based on Gagné's (1968, 1977) cumulative learning theory and learning hierarchies. However, there has been a growing recognition that such hierarchical analyses, although valid and useful, are insufficient for prescribing or developing optimal sequences for a range of entire subject matter areas (see Gibbons, 1977) and that they are irrelevant for prescribing or developing optimal synthesizers.

As a result, much attention has been paid recently to the use of relational networks and/or digraph theory (Harary et al., 1965) for the analysis of subject matter content (Crothers, 1972; Pask, 1975; Shavelson, 1974). Yet this emphasis has gone to the opposite extreme: rather than assuming that only one type of content relation (the learning prerequisite) is sufficient for an analysis of subject matter content for instructional design purposes, most of these relational network analysts (many of whom, in all fairness, are not instructional-design-oriented) seem to assume that content should be analyzed as to an awkwardly large number of different types of relations, and that all these diverse relations should be represented together in one large network.

There are two major problems that instructional designers encounter in attempting to use such network approaches for their content and task analyses. (1) These networks include many kinds of relations that are not of value to them for the purposes of selecting, sequencing, or synthesizing the subject matter components. Usually the relations are too detailed. (2) These networks often do not clearly identify the nature of each relation (i.e., the meaning of each line between "modules"), and often the relations of most importance to designers are not adequately identified or clearly portrayed.

We propose that, for purposes of instructional design, a small number of types of pervasive content relations is all that is necessary, and that each type should be represented in a different diagram as a different kind of "structure". However, these types of pervasive content relations must be selected such that they have prescriptive value for instructional designers' use of sequencing and synthesizing strategies. The following are some types of content relations which we hypothesize to have these properties.

**Types of Pervasive Content Relations and Structures**

A content structure, as referred to in this paper, is a diagram which shows just one kind of pervasive relation within a unified (i.e., interrelated) subject matter area. A pervasive relation is one which exists both "below" and "above" at least one concept, principle, etc. These two terms will be