

LECTURE 3, READING 4

**STRUCTURAL  
KNOWLEDGE:**  
**Techniques for Representing, Conveying,  
and Acquiring Structural Knowledge**

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Reprinted by permission of the publisher from: Jonassen, *Structural Knowledge: Techniques for Representing, Conveying, and Acquiring Structural Knowledge*. Hillsdale, NJ: Lawrence Erlbaum, 1993. Ch. 12 Implicit methods for conveying structural knowledge through frames and slots, p. 125-131.

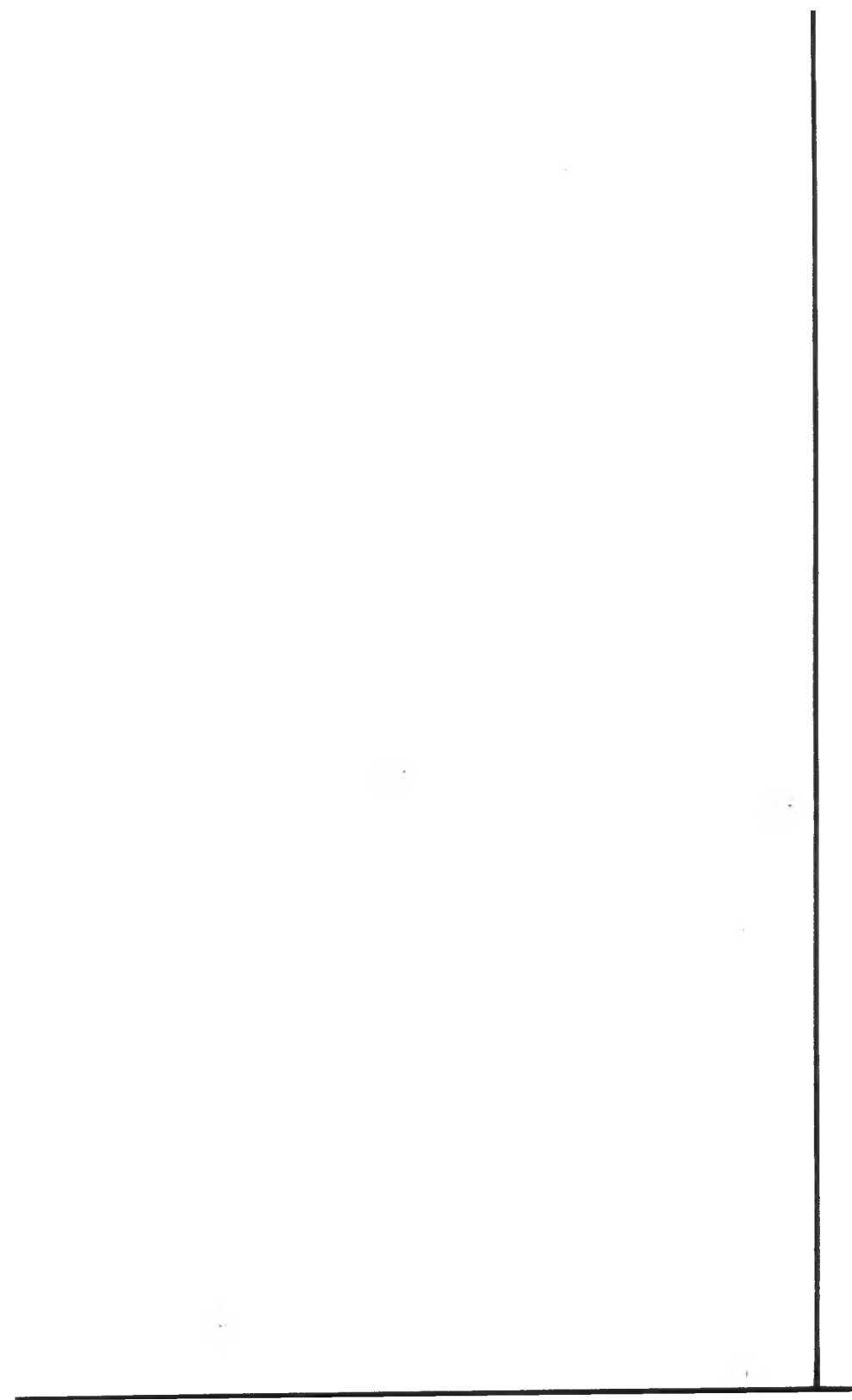


LAWRENCE ERLBAUM ASSOCIATES, PUBLISHERS

1993

Hillsdale, New Jersey

Hove and London



## *Implicit Methods for Conveying Structural Knowledge Through Frames and Slots*

### DESCRIPTION OF FRAMES AND SLOTS

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Marvin Minsky first introduced the notion of using "frames" and "slots" for representing the structure of knowledge (Minsky, 1975). In Minsky's frame theory, a frame is a data-structure for organizing stereotypical events or situations. Each frame has certain information attached to it, which presents expectations for what will happen next, the location of certain items, and so on. For example, one might have a frame about a child's birthday party. When one thinks about a child's birthday party, the appropriate frame is accessed, and certain information will be brought forward. One may expect that at this type of party there will be gifts for the birthday child, a cake with candles, and perhaps party games or some form of entertainment. For each frame there will be categories of information, referred to as slots, which must be filled with specific information for each instance of the frame. Taking the example of the birthday party, there may be a cake slot, which would be filled with information about the type of cake served at a given party. There may also be a games slot, to be filled with information about the types of games played at that party.

Although Minsky's frame theory was meant to explain how the mind works to organize information into knowledge systems, Armbruster and Anderson have applied frame theory to the organization of text. Their work has focused on the identification of generic, content-dependent structures, referred to as frames. Frames provide a general outline for examining a discipline's structure, while slots are the categories of information within the frames. Thus, slots hold the information about the subject area, while frames provide the main organizational structure. For example, this volume organized by a techniques frame, with slots for "description," "examples," "applications," "procedures," "effectiveness," "learner interactions," and "content interactions." To gather an understanding of the techniques included here, information about each of the techniques is entered into these predefined slots, thus providing parallel information about each of the techniques covered.

Frames can be of two main types: static, or dynamic. Static frames are descriptive — they use a listing of properties or attributes of a concept to convey the general ideas about the subject area. Slots within these static frames are the specific properties or attributes that are to be described. There is no particular order in which this content must be presented. For example, if an anatomy textbook were organized according to a "systems" frame, it makes no difference whether the first chapter deals with the cardiovascular system or the neurological system. The order in which slot information is presented is determined by the writer according to his or her preference.

Dynamic frames, on the other hand, have causal or directional relationships between slots. A common dynamic frame that has been identified is the "Goal Frame," which has slots for "goal," "action," and "outcome." This frame has a definite direction, as goals precede actions, and actions necessarily precede outcomes. Thus, the sequence of instruction within a dynamic frame is defined by its slots.

## **Rationale**

The use of frames and slots to organize text material is based on schema theory (Armbruster & Anderson, 1984). A schema refers to the organization of information in an individual's memory structures. According to schema theory a learner will seek to activate prior knowledge to assist in comprehension of new material. When reading text a learner activates his or her schema that is relevant to the text topic and creates a model for understanding the new material based on that prior knowledge. This schema sets up expectations for the type of information that is needed to understand a content area. Thus, comprehension and retention of the new material is enhanced when material in text is organized in a way that is familiar to the learner. Frames and slots were developed as a means of providing coherence in text by using the same organizing structure from one section to the next. Thus, with the first chapter from a text organized with frames and slots, the learner develops a schema for understanding the content area. With subsequent chapters organized in the same manner this schema is reinforced and refined to include more detailed understanding of the content.

## **EXAMPLES OF FRAMES AND SLOTS**

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When frames and slots are used to organize text, the headings within text correspond to the various slots of information that is presented. For purposes of presentation here, however, slots and frames are presented in a matrix format.

### Art Periods

	Carolingian	Gothic	Byzantine	Renaissance
Major Features				
Time				
Historical Events				
Key Artists				
Impact on Society				

Fig. 12.1. Frame and slots for art periods.

A text on periods or styles of art may include the slots that are shown in Fig. 12.1. The major features or characteristics that distinguish one artistic style from another would be discussed. The text could also address the time period or periods in which this type of art was predominant, as well as any historical events that may have influenced the development of the style. Key artists whose work characterizes the style of interest should be described, and examples of their works of art could be illustrated. Finally, the influences of the art style on society could be discussed.

Diseases of humans, animals or plants might also comprise a frame (Fig. 12.2). Slots for the diseases frame might include the presenting signs and symptoms of the disease, the etiology, or cause of the disease, its prognosis, treatment, and risk factors associated with acquiring the disease. Similarly, a "Drugs" frame could include slots for the purpose of the drug,

its chemical composition, mechanism of action, side effects, and known drug interactions (Fig. 12.3).

### Diseases

	Parkinson's Disease	Huntington's Chorea	Friedreich's Ataxia
Etiology			
Signs and Symptoms			
Diagnosis			
Treatment			
Prognosis			

Fig. 12.2. Frame with slots for "Diseases."

## APPLICATIONS OF FRAMES AND SLOTS

Frames can be used to organize textbooks or other instructional materials. First, the major concepts that are to be taught must be determined, and the attributes of each concept identified. The attributes then become the slots for the frame, and the frame itself can be identified from the slots. Slots can serve as headings and subheadings within texts, thus explicitly conveying the structure of the content. Likewise, since slots are the main ideas or key points in a piece of instruction, they can serve as a guide for writing introductions and summaries of the text.

### Drugs

	Acebutolol	Digoxin	Nitroglycerin	Amiloride
Purpose				
Chemical Composition				
Mechanism of Action				
Side Effects				
Interactions				

Fig. 12.3. Frame with slots for "Drugs."

Use of frames and slots should help learners to organize their thoughts and develop a stable mechanism for thinking about a subject area. The repetition of the same slots throughout a text (or other instructional product) should serve to reinforce the organizational scheme, thus stabilizing the learners' schema.

Frames and their respective slots can be used as class exercises or homework assignments (Armbruster & Anderson, 1985), and can assist in the preparation of test items. As an exercise, students may be asked to fill in a matrix with appropriate of information. In constructing test items, one could use the boxes in the matrix as a basis for questions, thus ensuring that students are asked about main ideas.

Frames and slots can also be used to evaluate textbooks, to determine whether all of the important content that should be covered on a topic is

actually provided in the text (Armbruster & Anderson, 1984). Questions can be developed for each slot in a frame, and the text passage reviewed to determine whether the question is answered. Well organized textbooks should contain information for each of the slots in the frame. If such information is missing, perhaps another textbook should be considered for adoption, or additional instructional materials should be developed to augment the text.

## **Conveying Structural Knowledge**

Frames and slots are primarily used to convey knowledge about a subject area in an organized manner. The use of slot names as headings in the text helps to convey the important categories of information in a content area, a key component of structural knowledge. Generic frames have been identified for Theories (Dansereau, 1985), Structure, Mechanism, Process, Hypothesis-Theory (Lunzer, Davies & Greene, 1980, cited in Armbruster & Anderson, 1985), Systems, Biomes, Technology, People, Goal, Problem/Solution, and Compromise (Armbruster & Anderson, 1985). Use of slots provides learners with a consistent framework for organizing their knowledge in a content area. In addition, structural knowledge is enhanced with the use of matrices which display key information about a content area in a small space. Such matrices can be used as an organizing framework for a course, showing learners how key concepts are similar to or different from concepts previously learned.

## **Acquiring Structural Knowledge**

Frames and slots can provide guidelines for information seeking by students. Again, learners can be given a blank matrix as a homework assignment, with the slots on the matrix indicating the key categories of information which they must find. Alternatively, learners may be required to generate their own slots for a given content area. In this instance, learners must gather information and then organize it themselves, creating their own categories of information. This learning activity can promote learning of relationships between concepts, and can also help to organize content for writing assignments.

## **PROCEDURE FOR DEVELOPING FRAMES AND SLOTS**

1. Determine the content to be conveyed, and the purpose for conveying the information.
2. Is there an existing frame available for organizing this content (for example, theory, structure, process, system introduced earlier)? Each of these frames has associated slots identified, into which a variety of in-



formation from different content areas might fit. If one of these frames matches the intent of the writing, the slots can be used to organize the text.

3. If no suitable generic frame has been identified for the content area you are interested in, create your own frame and slots. Think about the content area and identify the major concepts that must be conveyed for several instances of the major content area. Does the same type of information apply to different instances of the major topic area? If so, name that type of information, and include it as a slot.
4. Continue to identify slots (categories of information on the content area) until all of the relevant categories have been identified.
5. Determine whether there is a logical order or sequence for presentation of the content. Is one category of information prerequisite for understanding information in a subsequent category? Alternatively, one piece of information may seem to fit more appropriately when sequenced before a second piece of information. For example, when discussing styles of art, it makes sense to sequence information about the time in which a particular style was popular prior to discussing any historical events that may have influenced the style. Similarly, in an anatomy and physiology text it makes sense to convey the anatomy of a body system prior to discussing that system's function, because structure often governs function.

## **EFFECTIVENESS OF FRAMES AND SLOTS**

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Little empirical research on the effectiveness of frames and slots for conveying structural knowledge can be found in the literature. More extensive research is needed to validate the use of frames and slots to organize text materials. One study, however, does indicate that this method of organizing text is of some value.

- Subjects who were trained to use a frame with its slots to organize information about scientific theories performed significantly better than the untrained group on an essay test over text material on scientific theories (Dansereau, 1985).

### **Learner Interactions**

It is possible that some learners would benefit from the structure provided by the use of frames and slots, while other students are less affected by this organizational method. However, few studies have addressed this issue. In the study of the effectiveness of the Scientific Theories frame in facili-

tating learning, performance on a standardized vocabulary test was used as a covariate, with nonsignificant findings (Dansereau, 1985). Further research on potential differential effects of this strategy for learners with different abilities is needed.

## Content/Task Interactions

Most of the generic frames that have been identified deal with the sciences. For example, Dansereau (1985) identified a frame for scientific theories. The slots that accompany this frame are categories of information that one can acquire about a scientific theory, such as the chief developer of the theory, the history of the theory, a description of the theory, its consequences, and evidence supporting the theory. These categories of information help a learner organize their thoughts about the various theories learned.

Frames appropriate for use in the social science frames have been developed by Armbruster (1984) and Armbruster and Anderson (1984, 1985). These frames include the Goal and the Problem/Solution frames for structuring history textbooks. Both the Goal and the Problem/Solution frames are dynamic. These frames convey action, or historical events. Other social science frames may be static frames. A Cultures frame, for example, includes slots for Technology, Institutions, Language, and Arts. Content for each of these slots can be included for any different culture being studied (Armbruster & Anderson, 1985).

Little research has been conducted into the effectiveness of frames and slots for the various content areas. Although a number of frames have been developed for different content areas, it is unclear whether the frame approach to organizing instruction is better suited to some content areas than others.

## Advantages of Frames and Slots

- Frames and slots provide a method for organizing text passage that helps to ensure that important content is included in the text.
- Slots can serve as headings and subheadings within texts, thus explicitly conveying the structure of the content.
- Frames and slots can help writers organize introductions to, and summaries of text by reminding the writer of the main ideas in text.
- Use of frames and slots should help learners to organize their thoughts and develop a stable mechanism for thinking about a subject area. The repetition of the same slots throughout a text should serve to reinforce the organizational scheme, thus stabilizing the learners' schema.

## Disadvantages of Frames and Slots

- Frames and slots provide guidelines for organizing text based primarily based upon hierarchical relationships between ideas. No guidelines are provided in this method for conveying relationships between specific ideas in static frames.
- A limited number of generic frames have been identified. While these frames, and their associated slots, may be of use in some disciplines, this group of frames certainly does not encompass all of the content that may need to be conveyed to learners.
- Little, if any, empirical evidence of the effectiveness of frames in conveying structural knowledge is available. Although this method of organizing text may be theoretically appealing, it is not clear whether the use of frames actually improves student learning.

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