

Essay: Choose a Learning Theory for a Research Abstract

Abstract to Address: Our concern in this study was to examine the relationship between problem-solving performance and the quality of the organization of students' knowledge. We report our findings on the extent to which content and connectedness indicators differentiated between groups of high-achieving (HA) and low-achieving (LA) Year 10 students undertaking geometry tasks. The HA students' performance on the indicators of knowledge connectedness showed that, compared with the LA groups, they could retrieve more knowledge spontaneously and could activate more links among given knowledge schemas and related information. Connectedness indicators were more influential than content indicators in differentiation between the groups on the basis of their success in problem solving. The tasks used in the study provide straightforward ways for teachers to gain information about the organizational quality of students' knowledge.

Appropriate Learning Theory for the Abstract:

Cognitive Information Processing (CIP) refers to the body of learning theories that share an approach to learning that aims to explain how the brain physically functions during the acquisition of information through external inputs. CIP theorists generally assume a three-stage model for memory (see Figure 1), but differ in the mechanisms and structure they ascribe to knowledge structures (schema). While a number of CIP theories could inform the study outlined in the preceding abstract, I believe that propositional network models for memory storage and processing are best suited as a theoretical framework of the study. Before providing support for this claim, it may be useful to include a brief overview of the assumptions, results, and implications of CIP in the study of knowledge acquisition and storage.

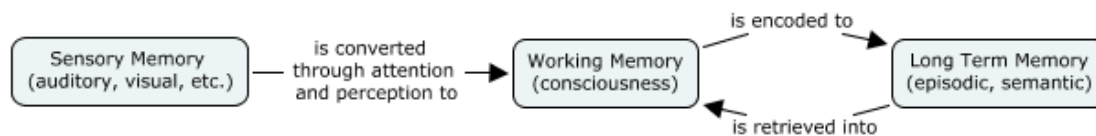


Figure 1. Three-stage model for memory first developed by Atkinson (Driscoll, 2004).

Information processing began with the basic recognition (assumption?) that human cognition is analogous to the mechanical operations of computers. This analogy, while naturally insufficient for describing all cognition, provides (a) a vocabulary for describing cognition, (b) a three-stage model for memory (sensory memory, working memory, and long term memory (LTM)), (c) an assumption that once stored, LTM is stored permanently, and (d) a view of knowledge as structured in the brain via physical associations, concepts, and relationships among concepts. These assumptions reflect an exogenous constructivist epistemology—that knowledge is built by the individual and stored in memory in a way that reflects sensory inputs accurately (Ernest, 1996).

Early results in information processing research relate to memory tasks. For example, Miller found in 1956 that 7 ± 2 digits can be recalled in a digit-span test (Driscoll, 2004). The capacity of working memory can be increased through *chunking* data into larger basic units (bits) and *rehearsing* lists, although *primacy* and *recency* effects have been shown to influence the ability of individuals to recall unfamiliar lists.

Elaborative encoding techniques promote the permanent storage of knowledge in LTM. Examples of elaborative encoding techniques include imposing organization, hierarchies, concept trees, mnemonics, mediation, and self-questioning. While the processes of maintaining data in working memory and storing it in LTM were early focuses of CIP researchers, the processes underlying retrieval of information has led

cognitive scientists to consider aspects of recall, recognition, and forgetting. The ability to recall information without cues is significantly lower than the ability to recognize information, and *forgetting* may occur through a combination of 1) failing to encode information to LTM, 2) failing to retrieve information because of cueing problems, and 3) interfering knowledge due to knowledge structures that contain related concepts. Forgetting is believed to be heavily influenced by the organization of LTM and strength of memory traces.

Although information processing assumes knowledge to be organized in LTM and processed according to the three-stage model, the various theories in CIP differ in their descriptions of these processes. Semantic Network theory considers information as stored in concept networks, with relationships between concepts acting as edges (pairwise associations) between nodes (concepts) in a graph. Feature Comparison theory, holds the less mathematical view that concepts are stored in terms of universal features and typical features. For example, I might store the concept of “function” as requiring a domain of inputs, but generally think of functions as typically having a domain of real numbers. Other theories of information processing include propositional networks, connectivist networks, and dual coding, but I will limit my discussion to propositional networks because they provide a meaningful framework for considering the research abstract motivating this essay.

The most comprehensive and accepted theory in CIP is Anderson’s ACT-R theory (Driscoll, 2004), which holds that knowledge is stored in propositional networks, whereby nodes are logical propositions with a subject and a predicate. This model of LTM allows the brain to search information using Boolean logic and provides a framework for a deep analogy between computer processing and human cognition. The propositional model for information networks can also provide a framework for evaluating the organization of knowledge. In much the same way that computer networks are evaluated by the multiple connections and speed of processing they afford users, mental networks of knowledge can be evaluated according to the complexity of the relationships and propositions related to a specific domain.

The potential application of propositional network theories to assessing the quality of organization in students’ knowledge is a primary reason for my choice of applying CIP to the abstract in this essay. By measuring the ability of students to retrieve knowledge that researchers’ believe to be related via propositions, the authors of the research described in Abstract 3 would be able to assign quantitative and/or qualitative scores to students’ organization of knowledge within mathematical domains. When the authors refer to high-achieving students’ high degree of connectedness and ability to “retrieve more knowledge spontaneously” and “activate more links among given knowledge schemas and related information”, the authors presuppose a network structure for students’ representation of mathematical knowledge.

The researchers’ theoretical framework is one that allows for the application of principles in CIP toward measuring the quality of students’ schemas as an explanatory variable in the study of academic performance. The researchers suggest, in fact, that the connectedness of knowledge networks may even be a better predictor of student performance than measures of the content knowledge of the students. In essence, the implications of studies related to both the structure of LTM and the processes underlying retrieval of information can be combined to inform the study outlined in Abstract 3.

References

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- Ernest, P. (1996). Varieties of constructivism: A framework for comparison. In L. P. Steffe & P. Nesher (Eds.), *Theories of mathematical learning* (pp. 335-350). Mahwah, NJ: Lawrence Erlbaum Associates.