Psychological Foundations of Instructional Design for Emerging Computer-Based Instructional Technologies: Part I

Michael J. Hannafin
Lloyd P. Rieber

Computer-based instruction (CBI) has strong historical roots in behavioral psychology. In many cases, behavioral CBI is very effective in meeting instructional needs. Criticisms of CBI, centering around inadequate attention to higher-level learning, underline some of the shortcomings of rigid adherence to behavioral design paradigms. Recent advances in cognitive psychology have revealed alternatives rarely applied outside of experimental settings. Whereas both behavioral and cognitive influences are potentially important, few attempts have been made to extrapolate the contributions of both to the design of CBI. In this article, the contributions of behavioral and cognitive psychology to the design of CBI are reviewed and analyzed.

Despite obvious powers for presenting, manipulating, and managing instruction, the instructional potential of computers has rarely been exploited. While the relationship between basic learning processes and instructional design should be obvious (Gagné & Glaser, 1987; Knirk and Gustafson, 1986), little evidence of this relationship is evident in typical computer-based instruction (CBI). Whatever the causes, the application of learning and cognition research to the design of computer-based instruction has been rare. Since evidence suggests that the computer is not inherently superior to other instructional media, effective computer-based instruction must be based on rational learning theories (see reviews by Clark, 1983, 1985).

As an initial perspective in the design of CBI, it is useful to consider the evolution of instructional design research and development. Instructional research has evolved from being predominantly behaviorally to cognitively oriented (Case & Bereiter, 1984; Gagné & Dick, 1983; Shuell, 1986; Wittrock, 1978). Although there are notable exceptions (cf. Merrill, 1988; Tennyson, 1984), comparatively little cognitive research has been specifically applied to the design of CBI. Most CBI has followed more traditional instructional design models that have evolved based principally on behavioral principles.

Varied psychological research findings and instructional design models have important implications for the design of CBI. In this article, several key concepts from behavioral
and cognitive research and theory are examined. This examination provides the foundation for an empirically based design framework which is discussed elsewhere in this issue (Hannafin & Rieber, 1989). Although neither all contributions nor complete treatment of the contributions can be provided in this article, several important aspects with particular relevance to the design of CBI have been included.

BEHAVIORAL INFLUENCES IN THE DESIGN OF CBI

Reinforcement theory is fundamental to behavioral psychology (Skinner, 1968). The theory views learning as the formation of stimulus-response associations (cf. Gropper, 1983). Behaviorally based CBI is characterized by small, complete lesson units, controlled lesson sequences, and discrete, discernible steps. Such designs typically dictate learning paths directed toward defined objectives and measurable performance criteria.

Foundations of Behaviorism

Stimulus-response (S-R) associations are formed through conditioning. In classical conditioning, a neutral stimulus is paired (presented continguously in space and time) with one that is known to produce a response until the neutral stimulus alone begins to elicit the response. For example, when an instructor turns toward a chalkboard during a lecture, students prepare to record notes even though the act of turning itself is not the action or stimulus that initially elicited the notetaking. In operant conditioning, students produce a particular response under prescribed conditions before rewards are provided. The response is considered to be instrumental in producing the reward. Most behavioral influences in CBI are based on operant approaches.

When a stimulus reliably evokes a response, the response is under stimulus control. The student must first discriminate the controlling stimulus from competing stimuli and generalize its relevant features to other contexts (Underwood, 1966). Prompting, cueing, and fading are used to establish this control. Prompts and cues act as supporting stimuli which explicitly direct learners to relevant aspects of a lesson (Hannafin & Peck, 1988). In addition, when a stimulus already controls a particular response, it can be used to transfer control to other stimuli. If, for example, children are to read the word "cat," they might be shown both the word and the familiar picture of a cat. Eventually, the student should be able to not only make the initial discrimination, but generalize saying the word in other contexts (e.g., readers, labels, chalkboards).

Stimuli presented as a consequence of responses can act as reinforcers if they closely follow a response. Both positive reinforcement and negative reinforcement are designed to increase desired responses and to shape appropriate behavior. Students seek positive reinforcement and avoid negative reinforcement, both of which increase the probability of a desired response. Reinforcement statements such as "good" or "correct" are usually presumed to be positive, while statements such as "incorrect" or "wrong" are presumed to be negative. However, such statements meet the operational definition of reinforcement only if they increase the probability of desired responses—an assumption designers rarely validate. (Negative reinforcement is often confused with punishment, which by definition, seeks to decrease the probability of an undesired response.) Reinforcement can be continuous (after each response) or intermittent (periodical). Intermittent reinforcement can be provided after a fixed or variable number of responses (a ratio schedule) or after a fixed or variable amount of time has lapsed (an interval schedule). These schedules have different effects on both how associations are made and how behavior is shaped, as well as on the durability of conditioned responses (Reynolds, 1968). In some cases, learned behaviors are thought to be maintained because they become intrinsically reinforcing.

Reinforcement and feedback are often synonymous. Although several functional