

Instructional Design

Advanced article

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Instructional design is that branch of knowledge concerned with theory and practice, related to instructional strategies and systematic procedures for developing and implementing those strategies.

INTRODUCTION

Instructional design is a construct that refers to the principles and procedures by which instructional materials, lessons, and whole systems can be developed in a consistent and reliable fashion. The principles and procedures can be applied to guide designers to work more efficiently while producing more effective and appealing instruction suitable for a wide range of learning environments.

As well as being a construct, instructional design is also a field of theory and practice within the larger field of instructional technology. Instructional designers work in many settings, including schools, colleges and universities, corporations, and military and government agencies.

This article will address in turn the underlying instructional principles, the procedural guides by which these principles are put into application, and finally the construction of learning environments as an alternative way of putting the principles into action.

PRINCIPLES

The design of instruction can be informed by principles drawn from many disciplines, including educational psychology, cognitive science, systems theory, communications, philosophy, anthropology, and organizational theory.

Behaviorist Psychology Sources

The original momentum for the modern concept of instructional design came from B.F. Skinner's

suggestions regarding the application of operant conditioning principles to education (Skinner, 1954). His vision became instantiated in programmed instruction, which was based on the following set of prescriptive principles:

- (1) an ordered sequence of stimulus items, (2) to each of which a student responds in some specified way, (3) his responses being reinforced by immediate knowledge of results, (4) so that he moves by small steps, (5) therefore making few errors and practicing mostly correct responses, (6) from what he knows, by a process of successively closer approximations, toward what he is supposed to learn from the program. (Schramm, 1962, p. 2)

As research and practical experience accumulated, the generality of many of these principles came into question. That is, the sequence of experiences, the nature of the response, the timing of feedback, and the size of steps all appeared to be contingent on various learner and learning conditions. The prescriptions of programmed instruction were broadened and reduced by Popham (1971) to four principles:

- (1) Provide relevant practice for the learner. (2) Provide knowledge of results. (3) Avoid the inclusion of irrelevancies. (4) Make the material interesting. (Popham, 1971, p. 171)

Cognitive Sources

Since the 1960s, instructional design has been increasingly informed by principles drawn from other sources, especially cognitive science and cognitive psychology. Cognitive models for instruction emphasize the importance of the learner's cognitive and affective processes in mediating the effects of instruction. From this perspective, learners use their memory and thought processes to generate strategies as well as to store and manipulate mental representations of images and ideas.

Robert Gagné was a leading interpreter of learning theory into instructional theory. Early editions of his influential book, *The Conditions of Learning* (Gagné 1965), proposed that the information-processing model of learning could be combined with behaviorist concepts to provide a more complete view of learning tasks. From descriptive theories of information processing, Gagné deduced prescriptive theories about instruction methods ('external conditions of learning'). His list of nine 'instructional events' became a robust and influential conceptual schema for the planning of lessons:

- (1) gaining attention; (2) informing learners of the objective; (3) stimulating recall of prior learning; (4) presenting the content; (5) providing 'learning guidance'; (6) eliciting performance; (7) providing feedback; (8) assessing performance; (9) enhancing retention and transfer. (Gagné and Medsker, 1996, p. 140)

More recently, other descriptive theories of learning that are derived from a cognitive perspective have influenced further prescriptive theories and principles for instruction. Schema theory, which emphasizes the schematic structure of knowledge, is one of the major sources of influence. Ausubel (1980) described schemata as providing ideational scaffolding, which contains slots that can be instantiated with particular cases. These schemata allow learners to organize information into meaningful units. This theory implies that the learner's cognitive structure at the time of learning is the most important factor in determining the likelihood of successful learning. One instructional design principle derived from this theory pertains to the advance organizer – a brief outline based on the learner's existing knowledge, which serves as 'ideational scaffolding' for new learning. Ausubel proposed that advance organizers could activate broader and more inclusive knowledge, providing a cognitive structure for new meaningful learning.

Constructivist Sources

Other educational theories emphasize the importance of the ideas generated by learners themselves. Wittrock (1974) described a view of learning and instruction in which the 'generations' (mental activities such as summaries, pictures, analogies, and discussions) performed by learners influence the success of instruction. This emphasis on learner generation characterizes constructivism, which assumes that 'knowledge is individually constructed and socially co-constructed by learners based on

their interpretations of experiences in the world' (Jonassen, 1999, p. 217). Prescriptive principles from constructivism include the following:

- (1) Embed learning in complex, realistic and relevant environments. (2) Provide for social negotiation as an integral part of learning. (3) Support multiple perspectives and the use of multiple modes of representation. (4) Encourage ownership in learning. (5) Nurture self-awareness of the knowledge construction process. (Driscoll, 2000, pp. 382–383)

An alternative view of constructivism, known as the 'situated cognition' perspective, which is derived from anthropology (Lave and Wenger, 1991; Barab *et al.*, 1999), proposes that the need to understand the learning context supersedes the need to understand the mental processes going on inside individual learners – that is, the learner and the environment are always interacting. For example, what is understood as memorized algorithms in a mathematics classroom differs from what is understood through grappling with a real-world carpentry problem.

The field offers a wide variety of theories of instructional design that prescribe specific methods of instruction and the conditions under which they can best be used. A growing number of instructional design theories have been developed to address a wide range of learning situations in order to foster cognitive, psychomotor, or affective development. These include theories for such diverse types of learning as experiential, collaborative, and self-regulated learning, as well as emotional, social, and even spiritual development (Reigeluth, 1999).

Comprehensive Set of Design Principles

A recent synthesis by M. David Merrill (Merrill, 2001) provides a coherent and comprehensive overview of instructional design principles from an eclectic perspective, incorporating behaviorist, cognitivist, and constructivist conceptions:

- *Problem.* Learning is facilitated when the learner:
 - ...is engaged in solving a real-world problem;
 - ...is engaged at the problem or task level, not just the operation or action level;
 - ...solves a progression of problems;
 - ...is guided to an explicit comparison of problems.
- *Activation.* Learning is facilitated when the learner:
 - ...is directed to recall, relate, describe, or apply knowledge from relevant past experience that can be used as a foundation for the new knowledge;
 - ...is provided with relevant experience that can be used as a foundation for the new knowledge.

- **Demonstration.** Learning is facilitated when:
 - ...the learner is shown rather than told;
 - ...the demonstration is consistent with the learning goal;
 - ...the learner is shown multiple representations;
 - ...the learner is directed to explicitly compare alternative representations;
 - ...the media play a relevant instructional role.
- **Application.** Learning is facilitated when:
 - ...the learner is required to use his or her new knowledge to solve problems;
 - ...the problem-solving activity is consistent with the learning goal;
 - ...the learner is shown how to detect and correct errors;
 - ...the learner is guided in his or her problem-solving by appropriate coaching that is gradually withdrawn.
- **Integration.** Learning is facilitated when the learner:
 - ...can demonstrate his or her new knowledge or skill;
 - ...can reflect on, discuss, and defend his or her new knowledge;
 - ...can create, invent, and explore new and personal ways to use his or her new knowledge.

(Merrill, 2001, pp. 5-7)

APPLICATIONS

Instructional design theories and principles are put into practice by being embedded in procedural guides or protocols for instructional development. These often take the form of instructional systems development (ISD) process models.

ISD Process Models

Historically, instructional design can be seen as having two parents, namely the systems approach and behaviorist psychology. The relative contributions of each are difficult to assess because at the time when instructional design was conceived the two sources were quite intertwined. During the post-World War II period each of the US military services had developed doctrines for training development, all of which were based on the systems approach – a ‘soft’ version of systems analysis, itself an offshoot of operations research. Behaviorist learning theory was a pervasive influence in US military training, and was being enthusiastically explored in school and university instruction during this same time period. Many of those who had been involved in military training development were applying their craft in university research and development centers. Thus the systems approach and behaviorist concepts became

increasingly intertwined, both in the military services and in academia.

During the 1960s, the systems approach began to appear in procedural models of instruction in US higher education. Barson’s (1967) instructional systems development project produced an influential model and set of heuristic guidelines for developers. If one looks at the form and language of these early models, the influence of the systems approach paradigm is obvious. Early models instantiate the principles of gathering and analyzing data prior to making decisions, and using feedback to correct deficiencies in work completed. They include systems terminology such as ‘mission objectives,’ ‘transmission vehicles,’ ‘error detection,’ and so on. The ‘soft’ systems concept continued to evolve in terms of its application to complex problems in human organizations, since it was recognized that ‘hard’ mathematical systems concepts did not apply directly to complex clusters of human activities, which represented systems only in the loosest sense of the term. Thus the systems concept came to be seen more as an analogy or as a ‘means of *structuring a debate*, rather than as a recipe for guaranteed efficient achievement’ (Checkland, 1981, p. 150).

The largest group of models is derived from the ‘soft’ systems paradigm, commonly referred to as the ADDIE model (an acronym derived from the key steps in the model: Analysis, Design, Development, Implementation, and Evaluation). These steps identify a generic systems approach, similar to that applied in other fields such as software engineering and product design. The ADDIE approach is systematic in that it recommends using the decisions made at each step (the output) as the input for the next step. That is, the *analysis* stage begins by surveying the learners and learning environment in order to determine which learning problems are of high priority and should be chosen as objectives. In the *design* stage, those learning objectives are translated into lesson plans or blueprints. In the *development* stage, specific materials and procedures are created to give life to the blueprints. In the *implementation* stage, learners actually use the materials and procedures that were created. In the *evaluation* stage, the learners are assessed in order to determine the extent to which they mastered the objectives specified at the beginning, and revisions are made as necessary. The ADDIE family of models, represented by 13 different variations on the systems approach, has been analyzed by Gustafson and Branch (1997).

Instructional Theory-based ISD Models

In addition to generic ISD process models, a number of alternative models have been developed as guides to the application of particular instructional design theories. One of the earliest was *structural communication*, developed in the UK by Bennett and Hodgson (Hodgson, 1974). Originating as a reaction to the limitations of programmed instruction, structural communication involved a process of analysis and development contingent on different levels of thinking, namely creative, conscious, sensitive, and automatic levels (whereas programmed instruction lent itself only to the sensitive and automatic levels). The form of the instruction resembles a guided discussion, emphasizing the role of the learner as an active inquirer.

A more recent attempt to mold a process model around the constructivist view is the *reflective recursive design and development* model of Willis and Wright (2000). Their process revolves around three focal points, namely definition, design/development, and dissemination. It assumes

that designers will work on all three aspects of the design process in an intermittent and recursive pattern that is neither predictable nor prescribable. The focal points are, in essence, a convenient way of organizing our thoughts about the work. (Willis and Wright, 2000, p. 5)

LEARNING ENVIRONMENTS

Some approaches to instructional design focus not on the procedural steps involved in creating specific lessons, but on the construction of whole learning environments that have special features conducive to efficient, effective learning. Such learning environments can themselves be viewed as large-scale methods – frameworks that are created in order to immerse learners in a consistent set of instructional conditions. Examples include the personalized system of instruction (Semb, 1997), goal-based scenarios (Schank *et al.*, 1999), problem-based learning (Boud and Feletti, 1997), open learning environments (Hannafin *et al.*, 1999), and constructivist learning environments (Jonassen, 1999).

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Further Reading

Intellectual Ability

Introductory article

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CONTENTS

Intelligence
Creativity

Wisdom

Intellectual abilities comprise those higher-order cognitive skills that are involved in coping with the environments in which we live, including but not limited to learning and thinking skills. Intelligence, creativity, and wisdom are three of the major intellectual abilities.

INTELLIGENCE

Defining Intelligence

Intelligence involves the ability to adapt to the environment. But what specifically is involved in intelligent thinking?

Two symposia have sought to ascertain the essential features of intelligence, one in 1921 and the other in 1986. Features that have been proposed include: adaptation in order to meet the demands of the environment effectively; elementary processes of perception and attention; higher-level processes of abstract reasoning, mental representation, problem-solving, and decision-making; ability to learn; and effective behavior in response to problem situations.

Some researchers, such as Boring in 1923, have been content to define intelligence operationally, simply as the 'intelligence quotient' (IQ). Originally, IQ was defined in terms of a ratio of one's mental-age level of performance to one's chronological-age level of performance, but today IQs are defined in terms of how much one differs from the average. An average IQ is 100. Slightly more than two-thirds of IQs fall between 85 and 115.

Scientific definitions rely on tests such as those invented by Binet and Simon in 1916 to measure judgmental abilities or by Wechsler in 1939 to measure verbal and performance abilities. Earlier tests proposed by Galton in 1883 measured psychophysical abilities (such as sensitivity of hearing or touch). They proved to be less valid, in that they correlated neither with each other nor with success in educational settings.

Laypeople also can be asked to define intelligence, and it turns out that their definitions differ from scientists' definitions in placing somewhat greater emphasis on social competence. In one study by Sternberg and his colleagues, for example, laypeople defined intelligence in terms of three