

Instructional Design

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Brief Definition: That branch of knowledge concerned with theory and practice related to instructional strategies and systematic procedures for developing and implementing those strategies.

Instructional design is a construct referring 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, military, and government agencies.

The following sections will address, first, the underlying instructional principles, second, the procedural guides by which these principles are put into application, and third, the construction of learning environments, as an alternative way of putting the principles into action.

1. 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.

1.1. Behaviourist 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 a set of prescriptive principles: “a) an ordered sequence of stimulus items; b) to each of which a student responds in some specified way, c) his responses being reinforced by immediate knowledge of results, d) so that he moves by small steps, e) therefore making few errors and practicing mostly correct responses, f) 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. Programmed instruction’s prescriptions 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” (p. 171).

1.2. Cognitive sources

Since the 1960s instructional design has been informed increasingly by principles drawn from other sources, especially cognitive science and cognitive psychology. Cognitive models for instruction emphasize the importance of the learners’ 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 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, *Conditions of Learning* (Gagné 1965,

1977) proposed that the information-processing model of learning could be combined with behaviourist 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 & Medsker, 1996, p. 140).

More recently, other descriptive theories of learning that come from a cognitive perspective have influenced further prescriptive theories and principles for instruction. Schema theory, emphasizing the schematic structure of knowledge, is one of the major sources of influence. Ausubel (1980) described schemata as providing ideational scaffolding, containing 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. He proposed that advance organizers could activate broader and more inclusive knowledge, providing a cognitive structure for new meaningful learning.

1.3 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” performed by learners influence the success of instruction. Generations are mental activities performed by learners, such as summaries, pictures, analogies, and discussions. 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: “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, the “situated cognition” perspective, 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, that the learner and environment are always interacting. 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 instructional-design theories 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 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 (see, e.g., Reigeluth, 1999).

1.4. Comprehensive set of design principles

A recent synthesis by M. David Merrill (2001) provides a coherent, comprehensive overview of instructional design principles from an eclectic perspective, incorporating behaviourist, 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 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 show 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).

2. 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.

2.1. ISD process models

Historically, instructional design can be seen as having two parents—systems approach and behaviourist psychology. The relative contributions of each are difficult to assess because at the time instructional design was conceived the two sources were quite

intertwined. During the post-World War II period each of the U.S. 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. Behaviourist learning theory was a pervasive influence in U.S. 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 centres. So systems approach and behaviourist concepts became more and more intertwined, both in the military and in academia.

During the 1960s the systems approach began to appear in procedural models of instruction in U.S. higher education. Barson's (1967) Instructional Systems Development project produced an influential model and set of heuristic guidelines for developers. By looking 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 analysing 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 the like. 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 comprised systems only in the loosest sense of the term. So 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 in each step (the output) as the input for the next step. That is, the Analysis stage begins by surveying the learners and learning environment to determine which learning problems are of high priority and shall 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; and in the Evaluation stage the learners are assessed to determine to what extent they mastered the objectives specified at the beginning, and revisions are made as needed. The ADDIE family of models, represented by 13 different variations on the systems approach, is analysed by Gustafson and Branch (1997).

2.2. 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 U.K. by Bennett and Hodgson (Hodgson, 1974). Originating as a reaction to the limitations of programmed instruction, Structural Communication entailed a process of analysis and development contingent on different levels of thinking: creative, conscious, sensitive, and automatic

(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 mould 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—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” (p. 5).

3.0. Learning Environments

Some approaches to instructional design focus not on the procedural steps entailed 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 be viewed as large-scale methods themselves—frameworks that are created to immerse learners in a consistent set of instructional conditions. Examples include: personalized system of instruction (Semb, 1997), goal-based scenarios (Schank, Berman, and Macpherson, 1999), problem-based learning (Boud and Feletti, 1997), open learning environments (Hannafin, Land and Oliver, 1999), and constructivist learning environments (Jonassen, 1999).

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Glossary

constructivism: a perspective in Education that emphasizes learners' construction of knowledge as they attempt to make sense of their experiences.

goal-based scenario: a framework for instruction in which learners participate in a simulation of a complex situation, attempting to achieve a goal by practicing target skills and using relevant content knowledge.

instructional method: a set of instructions or actions having a specific structure, with the purpose of facilitating learning.

instructional systems development: an approach to instructional design that emphasizes a systematic process, progressing through the stages of analysis, design, development, implementation, and evaluation.

instructional technology: a field of theory and practice within Education in which a knowledge of the science of instruction and the art of teaching is applied to develop and manage, with economy and elegance, instructional materials and

systems that contribute to the provision of humane, effective learning environments.

personalized system of instruction: a framework for whole courses in which learners work individually, typically using print or audiovisual materials, on carefully sequenced units of instruction, each of which is followed by testing and immediate correction and remediation by a tutor.

programmed instruction: an instructional framework, typically in printed or computer-based format, in which the content is divided into carefully sequenced small units, each of which requires a learner response, which is followed by informing the learner of the correct response.

situated cognition: A theoretical perspective suggesting that learning is always situated and progressively developed through activity and that cognition is best treated as a tool that can be fully understood only through its use.

systems approach: a general way of viewing problems in their entirety, including internal interactions and external connections.