Rita C. Richey *Editor*

Encyclopedia of Terminology for Educational Communications and Technology

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Springer

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Dedicated To

The Commission on Definition and Terminology, which produced in 1963 the first monograph defining the field of Audiovisual Communications and its key terminology.

Donald P. Ely, Syracuse University, Chair of the Commission and Editor of the Monograph.

Henry A. Bern, Indiana University.

Samuel Cohen, Hewlett-Woodmere Public Schools, Hewlett, New York.

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Contents

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Preface

Words! Words! Words! I'm so sick of words!
Eliza Doolittle
In My Fair Lady

These words have been the cry not only of Eliza Doolittle but many a scholar, practitioner, and graduate student in the field of Educational Technology. The words that describe our field not only span a wide array of specializations and theoretical orientations, but to further complicate this state of affairs, the vocabulary of the field is frequently changing. New words emerge and the definitions of existing words change to reflect particular nuances of thought, technological advancements, or even the disparate global interpretations of a given term. This book is an effort of the current AECT Definition and Terminology Committee to address the challenges of this situation.

This book is not a glossary, but rather it is an encyclopedia of terminology that is central to the educational technology field. We seek not to simply define but to explain. These explanations describe the scope of a given concept, alternative views and interpretations of the term, and often future trends. Moreover, these explanations are rooted in the scholarly literature of the field.

Background

Fifty years ago, in 1963, the first definition of the field of audiovisual communication was devised as a part of the Technological Development Project of the National Education Association led by James Finn of the University of Southern California. The Commission on Definition and Terminology was directed by Donald Ely of Syracuse University. The 1963 definition was one stimulus for the formation of the Association for Educational Communications and Technology (AECT). Since that time AECT has formally defined and redefined the field yielding four additional officially endorsed definitions (1972, 1977, 1994, and 2008). These definitions have provided direction for establishing disciplinary boundaries. The emphasis given to terminology of the field varied in these different efforts.

The 1963 definition monograph included a glossary of terminology related to the field as it existed at that time [See Ely, D.P. (Ed.). The changing role of the audiovisual process in education: A definition and glossary of related terms. TDP Monograph No. 1. *AV Communication Review (11)*1, iv-148.] This glossary included terminology from other fields as well as that of audiovisual communication. Its goal was not only to serve as a reference but also to "establish generally agreed-upon parameters in the field" (p. 31). The definitions were derived from 35 pieces of literature, many of them glossaries themselves. Each term and its definition was printed twice—once in an alphabetical listing and then classified by content areas. The content areas were: Communication and Learning, Audio Reproduction, Broadcasting (including radio, television, educational television, and instructional television), Communication and Information Theories, Computers in Instructional Settings, Electronic Learning Laboratories, Photography and Cinematography, Programmed Instruction and Teaching Machines, Technological Development, and Visual Media.

In 1977 an expanded "definition book" was published that included another glossary of terms, one that was lengthy but not matching the scope of the 1963 list. The glossary in the 1994 definition of the field was directly related to the description and explanation of that definition; consequently, the glossary was much shorter and terminology was not viewed as a major emphasis of the committee. The 2008 definition book did not include a glossary of terms. In effect, this volume and the work of this committee rounds out the task.

The 2009–2012 AECT Definition & Terminology Committee chose to concentrate solely on the terminology critical to the discipline as another way of further defining who we are, what is important, and how we view the field. We have moved beyond the glossary orientation and into an encyclopedia format. This book attempts to cover all facets and the complexities of the field—from technology advances, to instructional design, to library science, to performance improvement. It will hopefully aid students new to the field, as well as seasoned scholars. To some extent this encyclopedia matches the goals of the original terminology work of 1963, serving both as a reference and as a way to identify the parameters of the field.

Procedures

Overview

The AECT Definitions & Terminology Committee includes persons representing the many interests and specialties of this field. For example, the committee includes librarians, instructional designers, performance improvement people, museum and visual literacy experts, as well as those who are skilled in technology and materials production. The committee also includes people who represent many arenas of practice (e.g., higher education, p-12 education, employee training). This breadth of expertise provided a necessary foundation for the identification and selection of terminology critical to the field.

The terminology selection process included the following general steps:

1. The committee agrees upon a general outline of the topical domains of the field;
2. Domain experts brainstorm to devise a large list of key concepts in the area;
3. Terms are clustered into like categories where appropriate;
4. The committee completes and analyzes a terminology survey which rates each term in terms of its criticality to the field;
5. Using survey results and additional expert input, the committee selects terminology to be included in the book;
6. The terms are again clustered into like categories where appropriate;
7. The committee prepares and agrees upon a model entry and writing guidelines; and finally,
8. Terminology entries are written, edited, and approved.

Terminology Identification

The first step in the terminology identification process involved describing the scope of the field. The task confronting the committee here was to generally identify the many topics addressed by the field's practitioners and scholars. Terms could then be identified which related to these many topics.

Six general categories of content were identified—foundations, instructional design, technology and media, analysis and evaluation, management and organizational improvement, and research and theory.[1] Thirty-two subcategories of content were then agreed upon. This framework was used as a springboard to the terminology brainstorming process.

Hundreds of terms were initially identified by the committee members working with topics in their areas of expertise. Obvious terms such as "instructional objectives," "cognitive learning theory," "distance learning," and "multi-media" were identified. In addition, somewhat more esoteric terms such as "ludology," "proximity sensing," and "sensory modality" were also identified.

The task then was to narrow the list by selecting those terms that were the most important to practitioners and scholars in the field. The first part of this process was to cluster some terms into more general groups. For example, the terms "concept," "integrative goal," and "fact" were grouped into a category called "learning types."

[1] It is interesting to compare these content categories with those used in the 1963 monograph, which had more of a technology emphasis. The field has expanded greatly over the years.

Many technology terms were grouped together, such as with the formation of a new term "social computing," which encompasses "folksomonies," "mashups," and "video blogs" among many others. This was still considered to be a part of the terminology identification process.

Terminology Selection

The first step in the terminology selection process involved committee members rating each term in terms of criticality. This was not a simple task given the fact that some terms critical to one specialization may have been entirely unknown to those in other areas. Mean ratings for each term were identified excluding the ratings of those who were not familiar with a given term. The highest rated terms were quickly accepted for inclusion in the book, and in general the very lowest ranked terms were excluded. As expected the difficulties came with decisions regarding those terms falling in the center of the rated items. Even though a general cutoff point was identified, some terms falling below that point were deemed critical by those with related expertise. These were then left on the "to do" list. The process of writing the individual entries tended to once again highlight the more critical terms which more readily attracted volunteers. However, selection decisions were made throughout the writing process during face-to-face meetings of the committee, and periodic conference calls. In some cases wording decisions were made in conjunction with the writers themselves who were experts in the particular area at hand.

Issues

A variety of issues arose during the course of conceptualizing and writing this book. These include:

- Which terms are central and most critical to the field and which are only related to the field?
- Should older terms be included?
- Should terms be clustered and if so, which ones?
- How should the terms be organized?

The Centrality and Criticality Questions

The educational technology field is not an island unto itself. It is rooted in a variety of other disciplines, including curriculum and instruction, educational psychology, communications, organizational management, and many fields with a technology focus. The centrality question is one of establishing boundaries. It is also a matter of determining which terms are most critical to establishing expertise in this field. Examining the centrality question involved a variety of decisions.

First, the committee identified those terms which appear to be essentially unique to our field. For example, "conditions of learning" was included because it has a unique role and meaning in instructional design. Moreover, it is central to understanding the field as a whole. Those in other fields may find this concept interesting, but it is not an integral part of their disciplines.

Next, the committee determined which terms, even though they may have originated in another field, are nonetheless especially important in our field. Learning theories, such as behaviorism and cognitive learning theory, originated in the field of psychology. Yet it would be impossible to understand this field without having a clear grasp of these concepts. Consequently, they were both included. Connectionism, another learning theory, however, was excluded. It is related to the theory of this field, but was not deemed to be as critical to a general understanding of the field as is behaviorism, for example.

Finally, the committee identified and excluded terms which, even though they are relevant and perhaps important to some specialty areas in the field, are not generally central to the field as a whole. Some technology terms posed unique dilemmas in this phase of the selection process. For example, the term "scripting language" is related to the work of some in this field, but is it important to a large portion of the field? Does it cross the borderline into centrality? We decided it did not. Cloud computing, on the other hand, is becoming an increasingly important part of technology and should be understood by everyone in the field, even though they may not be technology specialists. It is included in the book.

The Age Question

A book of this type naturally reflects the interests and the disciplinary culture of the times. However, several dilemmas arose when the committee confronted terminology currency issues. It was the clear consensus that this encyclopedia should be forward-reaching. It should include terms which were likely to be important for the foreseeable future, but what about terms of the past? Which terms should be viewed as classic foundations of the field and which terms are simply passé ideas? Terms describing obsolete audiovisual aids, such as overhead projector or cassette tape were not even considered. But should terms such as "objective" or "programmed instruction" be included? These are also very old terms. The committee decided to be guided by the literature. If there was current (i.e. within the last 5 years) literature that addressed an older topic, then it was deemed to be still relevant and appropriate for this encyclopedia. Consequently, "instructional objective" and "programmed instruction" are included here.

The Term Consolidation Question

The committee could (and did) generate far more terms than it was possible to seriously cover in the amount of time we were able to give to this project. A logical way of reducing the number of terms was to cluster similar ideas into a more general term, and this was done as discussed earlier. The clustering process, however, created other problems. First, there would be the need to guide readers to the right spot in the encyclopedia. This was readily handled with the use of "see" notations.

Another issue was more problematic. The very act of clustering terms in effect prioritizes them. For example when clustered, the term "gap analysis" may take on a somewhat secondary role to that of the more general term "analysis." Or the nuances of an explanation of "visual memory" may become lost in the larger discussion of the more general term "visual learning." These fundamental issues are for all intents and purposes unresolved. Writers simply did their best to highlight each subterm as much as possible given their space constraints. However recognizing the prioritizing implications, some terms were not clustered that conceivably could have been. For example, one could argue that "needs assessment" could have been clustered under the more general term "instructional design models," but it was kept as a separate entry because of its critical role in the field.

The Terminology Organization Question

The terms presented here could be organized in a number of ways. We used the simplest method—alphabetical order. This, however, is not the only approach possible. Terms could be listed in terms of major content domains, e.g. technology and media, analysis and evaluation, or management and organizational improvement. Remember that the 1963 monograph listed terms and their definitions twice, alphabetically and in content groupings. We too have hedged somewhat. The terms (without related discussions) are introduced first in content clusters to provide an overview of the encyclopedia, but in the heart of the book the terms are arranged in the tried-and-true alphabetical order.

How to Use This Encyclopedia

The listing of terms by content areas in the next section may help those who are interested in a particular area to get an overview of what is included. However, since this is a reference book, most readers will be turning to one term or another in a nonlinear fashion. There are two possible difficulties that could arise. First, given the peculiarities of our field, a reader may not be always using the same version of a term as was used by the committee and the author. For example, if readers look up

"Case-Based Instruction," they will find that we don't have an entry on that topic, but they should instead go to "Learning by Doing" to find something on their topic. Directions of this type are given in the "see" notes.

The second difficulty that can occur when using this encyclopedia involves readers who do find what they are looking for, but may not be aware of other related entries which would give them even more on their topic. For example, there is a large entry on "individualized instruction," but readers are directed to five other related entries (learner-centered instruction, mastery learning, open education, programmed instruction, and self-directed learning) through the "see also" note. "See" and "see also" notes immediately follow the entry titles. They should help readers navigate the encyclopedia.

Finally, some authors have provided a list of additional resources for someone interested in their topics. If such information does exist for a given entry, there is a note following the reference list directing readers to the "Additional Resources" section. This section follows the listing of entries beginning on page 331.

Conclusions

As with the many other Definition and Terminology Committee efforts, the fruits of our labors will at some point become out of date. Moreover, many (even including those of us on the committee) may question why one term or another has not been included. While we anticipate that other hard copy editions of this encyclopedia will be produced, revisions can (and should) be made at any time to the electronic version. Thus, technology should allow this encyclopedia to be continually evolving, thus resolving many questions which this book may generate.

In any case, this book can now serve as one description of the educational technology field at this time. It reflects current scholarship and thinking. In some cases, it points to future trends. In his forward to the 1963 definition and terminology monograph, James Finn noted that "today, not only have the media and varied contributions in theory increased, but the very boundaries and structure of the field seem to be part of an exploding universe" (see page vi in the 1963 AVCR article). This statement could have been made today. Finn suggested that the 1963 work might bring some order out of the chaos created by the many changes that were then occurring. This committee has similar hopes, even though our actual expectations are perhaps more modest.

Rita C. Richey, Chair AECT Definition and Terminology Committee, 2009–2012

Terminology by Content Domains

The following section lists the 186 terms that are addressed in this encyclopedia clustered into 6 major content areas and 19 subcategories. This section serves as a summary of the book and provides a view of related terms.

Foundations

Basic Areas of Study and Practice
- Audiovisual Instruction
- Communication
- Curriculum
- Development
- Educational Media
- Educational Technology
- Information and Communications Technology
- Instruction
- Instructional Design
- Learning
- Pedagogy
- Project Management
- Semiotics
- Technology

Policies, Standards and Regulations
- Accessibility
- Children's Internet Protection Act
- Children's Online Privacy Protection Act
- Competency
- Ethics
- Intellectual Property

Instructional Design

Micro-Instructional Strategies
  Advance Organizer
  Analogy
  Anchored Instruction
  Authentic Activity
  Chunking
  Cognitive Apprenticeship
  Comparison and Contrast
  Elaboration Strategies
  Elaboration, Types of
  Examples and Non-examples
  Feedback
  Generality
  Generative and Supplantive Instructional Strategies
  Interaction
  Mnemonic
  Practice
  Prompting
  Reinforcement
  Repetition
  Situated Cognition

Learner Characteristics
  Digital Divide
  Digital Natives and Immigrants
  Expertise
  Learner Characteristics and Traits
  Literacy
  Motivation
  Prerequisite Skills
  Self-Efficacy
  Self-Regulation
  Visual Competency

Technology & Media

Development Processes and Techniques
  Agent
  Animation
  Avatar
  Digital Mapping
  Digital Storytelling
  Graphics

Analysis & Evaluation

Analysis
Assessment
Criterion-Referenced Measurement
Evaluation
Evaluation Models
Need
Needs Assessment

Management & Organizational Improvement

Change Management
- Change
- Change Models
- Innovation
- Knowledge Management
- Learning Organization
- Organizational Change

Performance Improvement Processes
- Electronic Performance Support System
- Job Aid
- Management Systems
- Performance Improvement

Resource & Delivery System Management
- Information Access
- Information Classification
- Information Gatekeeper
- Information Resources
- Information Retrieval
- Information Storage
- Integrated Learning Systems

Research & Theory

Theoretical Orientations
- Attribution Theory
- Behaviorism
- Cognitive Dissonance Theory
- Cognitive Learning Theory

Communication Theory and Models
Constructivism
Cultural Historical Activity Theory
Dual Coding Theory
Information Theory
Information Processing Theory
Mathematical Model of Communication
Schema Theory
Taxonomy

Research Orientations
Design and Development Research
Design-Based Research
Designer Decision-Making Research

Learning Processes
Cognitive Load
Cognitive Processes
Cognitive Strategies
Community of Practice
Complex Learning
Conditions of Learning
Distributed Cognition
Field Dependence and Independence
Learning Path
Learning with Information
Memory
Metacognition
Perceptual Modality
Problem Solving Strategies
Scaffolding
Transfer
Visual and Pictorial Learning

A

Accessibility

SEE ALSO UNIVERSAL DESIGN FOR LEARNING

Accessibility describes "the degree to which a service or product gives learners the 'ability to access' functionality, services or materials" (Lewthwaite, 2011, p. 85). Similar to universal design in architecture which promotes accessible buildings (Mace, Hardie, & Place, 1996), universal design for learning (UDL) is a theoretical perspective conceptualized by the Centre of Special Applied Technology (CAST) to address issues with inaccessible curriculum (Rose & Meyer, 2002; Pisha & Coyne, 2001). UDL espouses that curriculum needs to be accessible for students regardless of their learning needs (Rose & Meyer, 2002; Hehir, 2005, CAST, 2011). Within UDL, accessibility is focused on reducing challenges to accessing services and materials instead of reducing challenges in curricular goals (Hitchcock, Meyer, Rose, & Jackson 2002; Rose & Meyer, 2002). "Educators can raise expectations and improve results for all students by providing greater access to the curriculum" (Jackson, Harper, & Jackson, 2005, p. 125). Research demonstrates that accessibility provides opportunities for participation and achievement for diverse students by overcoming access challenges inherent in classrooms (Edyburn, 2006; Hehir, 2005; Jackson et al., 2005; Rose & Meyer, 2002). Potentially every learner could benefit from intentional changes that remove unnecessary barriers to performance by improving universal accessibility. This dismantling of barriers can create accessibility through a universal design at the development stage, not as an afterthought (CAST, 2011; Rose & Meyer, 2002).

The traditional textbook, a standard resource in many educational settings, while adequate for many learners poses obvious barriers for others, especially for students with physical, sensory, learning, or cognitive challenges (Jackson et al., 2005; Meyer & Rose, 2005; Rose & Dalton, 2009). The rapid advances in technology have afforded greater opportunities for more efficient, effective access to curriculum through multimedia and assistive technology by reducing barriers inherent in the traditional textbook. Without technology, accessibility for students who require more support than is available from print is a time-consuming "onerous" task (Jackson & Harper, 2005). Digital text has a great capacity to provide accessibility for a variety of needs through its dynamic nature of being able to more readily "align content and tools" to meet individual student needs (Hitchcock et al., 2002; Jackson

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& Harper, 2005; Rose & Dalton, 2009). Students can use text to speech programs, for example, if they have difficulties with print such as visual loss, decoding difficulties, tracking difficulties, English language learning, or if they have a preference to listen rather than read (Meyer & Rose, 2005). Digital texts can have embedded supports such as extra descriptions or background information or easily accessed definitions for vocabulary. The multimedia features also enhance accessibility.

When curriculum is readily accessible for all students, any perceived support becomes less visible as students choose the access that works best for them. Accessibility is about promoting access for all students and recognizing that "providing both the stairs and ramps is preferable to trying to invent a single method of entry that works for all people at all times" (Rose, 2000, p. 69).

Evelyn J. Hickey

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Action Game
SEE DIGITAL GAME-BASED LEARNING

Activity Theory
SEE CULTURAL HISTORICAL ACTIVITY THEORY

Activity Systems Analysis
SEE CULTURAL HISTORICAL ACTIVITY THEORY

Adaptation of Innovation
SEE INNOVATION

Adaptive Systems
SEE COGNITIVE SCIENCE

ADDIE
SEE INSTRUCTIONAL DESIGN MODELS

Adoption of Innovation
SEE INNOVATION

Advance Organizer
SEE ALSO ANALOGY and COGNITIVE STRATEGIES and ELABORATION STRATEGIES and SCAFFOLDING and SCHEMA THEORY

An advance organizer (Ausubel, 1960) is a micro-level instructional strategy that is highly associated with the understanding level of Bloom's Taxonomy (Bloom, Engelhart, Furst, Hill & Krathwohl, 1956; Krathwohl, 2002). It is defined as:

> …introductory material at a higher level of abstraction, generality, and inclusiveness than the learning passage itself, and an overview as a summary presentation of the principal ideas in a passage that is not necessarily written at a higher level of abstraction, generality, and inclusiveness, but achieves its effect largely by the simple omission of specific detail (Ausubel, Novak, & Hanisian, 1978, p. 252).

Advance organizers differ from overviews because they are relatable to presumed ideational content in the learner's current cognitive structure (Ausubel, 1963, 1968).

The effects of advance organizers on learning were first tested because it was proposed that there was a hierarchy in learner's cognitive structure where highly inclusive conceptual traces were organized with less inclusive sub-concepts and specific information subsumed under them (Ausubel, 1960, 1963, 1968). It was proposed that more inclusive ideas should be deliberately introduced or activated in advance of learning material to bridge the gap between what the learner already knows and what she or he needs to know and/or to promote understanding and long-term retention.

There are two types of advance organizers, expository and comparative (Ausubel, 1963, 1968; Joyce & Weil, 1972). Expository organizers provide new higher-level concepts that are used to subsume (provide "ideational scaffolding" for) new material and are therefore used when students lack such inclusive subsumers (Ausubel, 1960, 1963, 1968; Ausubel & Fitzgerald, 1962). Comparative organizers, on the other hand, are used to activate existing schemas that are relevant to new ideas. The purpose of the organizer, in this case, is to provide ideational scaffolding for the new material and also, by pointing out explicitly the principal similarities and differences, to integrate new ideas and to promote discriminability between the new ideas and the previously learned ideas (Ausubel, 1963, 1968; Ausubel & Fitzgerald, 1961; Ausubel & Youssef, 1963; Fitzgerald & Ausubel, 1963).

In the 1960s and 1970s, much research was done on the effectiveness of advance organizers. In the wake of positive research findings, there was criticism that the definition and criteria for construction were vague, so different researchers had varying concepts of what an advance organizer is and could only intuitively construct one (Barnes & Clawson, 1975). Lawton and Wanska (1977) and Ausubel, et al. (1978) himself responded to the criticisms by providing the rationale and criteria for advance organizers, and it still remains one of the fundamental instructional strategies in the education field.

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Agent
SEE ALSO ANIMATION and AVATAR

In 1997, Erickson highlighted the double meaning of "agent." A first meaning stresses the presence of particular functional capacities. Agent then is used "to designate an autonomous or semi-autonomous computer program. An agent is a program that is, to some degree, capable of initiating actions, forming its own goals, constructing plans of action, communicating with other agents, and responding appropriately to events—all without being directly controlled by a human" (Erickson, 1997, p. 79). The second meaning stresses what is shown to the user. "Here, agent is used to describe programs which *appear* to have the characteristics of an animate being, often a human." (Erickson, 1997, p. 79). Of course, both meanings are not independent from one another.

The second meaning has especially attracted wide research attention. In order to clarify the function or particular characteristic of the agent, the notion is often used in combination with other qualifiers: interface agent, animated agent, intelligent agent, instructional agent, or most commonly "pedagogical agent." Pedagogical agents are defined as "animated characters designed to operate in an educational setting for supporting or facilitating learning" (Clarebout, Elen, Johnson, & Shaw, 2002, p. 268). In most definitions it is stressed that agents are animated and to some extent intelligent. They can move and/or talk and adaptively interact with the user. Depending on the specific context in which the notion is used that function may get highlighted or stressed. For instance, in the recent review by Heidig and Clarebout (2010) a pedagogical agent is described as "lifelike characters presented on a computer screen that guide users through multimedia learning environments" (p. 28). In the study by Moreno, Mayer, Spires, and Lester (2001) that stresses social agency, a pedagogical agent is described as "a likable cartoon figure who talks to the learner and responds to the learner's input" (p. 179).

Agents that have been studied in the last years differ on both the animation and the intelligence aspect. Some researchers assume that the voice of an agent is already sufficient (Mayer, Dow, & Mayer, 2003), whereas others especially focus on the visual features of the agent (Baylor & Kim, 2009). Furthermore, agents differ from one another with respect to their capacity to interact with the learner and to support specific aspects of the learning process. For Kim, Baylor, and the PALS group (2006) the ability to simulate social interaction is unique for pedagogical agents.

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Aggregator
SEE REALLY SIMPLE SYNDICATION

Analogy
SEE ALSO ADVANCE ORGANIZER

Analogies are a micro-level strategy for understanding-level learning in Bloom's taxonomy (Bloom, Engelhart, Furst, Hill, & Krathwohl, 1956; Krathwohl, 2002) that is especially useful for conceptual understanding. Reigeluth and Keller (2009) define analogies as "a component method that draws comparisons between something familiar and something unfamiliar for the purpose of learning or understanding the latter" (p. 37).

According to Ausubel, Novak, and Hanesian (1968), the learner must be able to relate new knowledge to his/her prior knowledge in a meaningful way in order for learning to occur. Stimulating prior knowledge is also emphasized in Gagne's nine Events of Instruction (Driscoll, 2000). Analogies can be effective for relating new knowledge to prior knowledge.

Gardner (1999) acknowledged the effectiveness of analogies and provided an example of using analogies. When explaining the processes of human social change, processes of biological changes within species can be used. However, Gardner (1999) cautioned that analogies can also develop misconception due to "parallels that do not hold" (p. 83). In the previous example, human social change does not have the random nature of biological evolution. To avoid this problem, Curtis and Reigeluth (1983) recommend explaining the limitations of an analogy to the learners.

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Analysis

SEE ALSO LEARNER CHARACTERISTICS AND TRAITS and NEEDS ASSESSMENT and PREREQUISITE SKILLS and SYSTEMS APPROACH

The term analysis refers to studying a complex system or entity by breaking it down into its smaller, interrelated parts. Analysis typically occurs in two distinct phases—the identification of component parts and the identification of the relationships between these parts and the whole system (Silvern, 1972). The component parts of a system can include things such as individuals, objects, processes, resources, and constraints. Relationships among these components can take several forms including the individuals and objects that enter or exit from a system, the flow of information between parts, and a chronological sequence among processes (Richey, Klein & Tracey, 2011).

Most systematic instructional design (ID) models include some form of analysis. Analysis in early ID models was principally directed toward examining instructional content and learner prior knowledge. For example, the first version of the Dick and Carey model (1978) included two kinds of analysis—instructional analysis involved breaking goals and content into subordinate skills, while learner analysis was used to identify which of those skills learners possessed prior to instruction. Even though designers still employ content and learner analysis procedures today, they also analyze organizational problems and their causes, learning and performance contexts, and a wider range of learner characteristics.

Performance analysis centers on the directions an organization wishes to go as well as the factors that encourage or impede performance (Rossett, 1999). Organizational analysis examines the vision, mission, values, goals, and strategies of the organization; environmental analysis uncovers factors related to the performance issue (Van Tiem, Moseley, & Dessinger, 2004). Needs analysis helps to identify optimal and actual performance, the gaps between these two conditions, and the organization's priorities for addressing these gaps (Kaufman, Rojas, & Mayer, 1993).

Furthermore, design models now incorporate contextual analysis procedures. For example, recent versions of the Dick and Carey model (see Dick, Carey & Carey, 2009) prescribe an analysis of the learning environment that considers the compatibility between the instructional site and the instructional requirements and the ability of the site to simulate the workplace. A contextual analysis of the performance setting is done to address managerial support, the social and physical aspects of the site where the skills will be applied, and the relevance of skills to the workplace.

Finally, a wide variety of characteristics are now addressed during learner analysis. These include factors such as individual differences, beliefs, and attitudes that may impact learning, transfer, and motivation, as well as mental models that may influence the selection of instructional methods (Richey et al., 2011).

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Anchored Instruction
SEE AUTHENTIC ACTIVITY

Anchored instruction is a pedagogical approach in which a realistic situation is the basis for the learning. Lee (2002) discusses how anchored instruction is part of a problem-solving exercise. A real-world situation is often presented to ground the problem and the subsequent solution path. Bottge and Hasselbring (1993) discuss the incorporation of authentic instruction. Here the lesson is not an abstract concept, but rather one that is based on concepts very familiar to the students.

Bauer (1998) discusses the use of a theme to present a unified and authentic lesson. The theme is a unifying concept that all of the students recognize. In this example, the instructor uses the program "Oregon Trail" as the anchor in a lesson to help preservice teachers integrate technology. Students were immersed in the software and commented on their level of engagement. They had to solve many problems in order to navigate the trail from St. Louis, Missouri to the Pacific Ocean. Their level of engagement increases as the complexity of the problems increase.

The literature supports a technology component to anchored instruction (Bauer, 1998; Bottge, Rueda, Serlin, Hung, & Kwon, 2007; Kariuki & Duran, 2004). Many instructors use a didactic approach to the process of teaching students how to integrate technology into the curriculum. In this approach, the teacher will demonstrate how a technology tool is used, provide directions on how to create materials, and then ask the students to create the materials. In anchored instruction, a teacher will present an authentic problem to be solved. The teacher may use any number of technology tools, but videos are very successful tools to overtly describe the problem to be solved (Barron & Goldman, 1994).

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Animation

SEE ALSO AGENT

According to Schlosser and Simonson (2006, p. 49), animation is defined as "a production technique that uses cartoon-like figures to create the illusion of movement. The use of sequences of cartoons, drawings, graphics, and models to simulate real-life characters in apparent motion."

The notion of mimicking movement from a series of still images began with thumbing a series of pages or the corners of cards, with the images carefully sequenced so that a viewing of the whole lot in quick succession appeared to the human eye as movement. When sprockets were added to photographic film to make the motion picture possible, artists began to develop the first animated movies using drawing on transparent celluloid sheets, which were then laid over a background and photographed one frame at a time. Another technique called "stop action animation" involves the creation of three-dimensional figures that are posed and photographed, then repositioned with tiny changes in gestures and location and photographed again. For a human eye to register a sequence of still images as moving smoothly and naturally, at least 15 and more often 30 or more images are sequenced in each second of the movie.

Animation in the digital age still comprises individual images sequenced to mimic action, but the process to develop computer-generated imagery (CGI) involves ever more sophisticated computer programs that take design information from the animator along with instruction algorithms to render sophisticated movement of objects or characters along with various techniques to create active backgrounds.

Seels and Richey (1994) differentiated audio-visual materials from computer-based technologies in their definition of the Domain of Development but also accounted for integrated technologies. Animation is a technique within the domain of development.

While it is a laborious and often expensive technique, animation in instructional design can be especially useful for providing context and emphasis to content that particularly benefits from motion to be fully understood and may be otherwise difficult or impossible to observe. For example, animation can be used to illustrate the process of human circulation of blood or the molecular activity that occurs when materials oxidize, or the algebraic relationship to plane geometry, or to give workers a broad understanding of the working innards of complex mechanical devices.

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Archives
SEE INFORMATION STORAGE

ARCS Model of Instructional Design
SEE INSTRUCTIONAL DESIGN MODELS and MOTIVATION

Artificial Intelligence
SEE COGNITIVE SCIENCE and EXPERT SYSTEM

Assessment
SEE ALSO e-PORTFOLIO

Building from similarities in definitions across a number of authors and researchers, assessment is defined as the deliberate process of collecting information about students' learning, using any of a number of different formats, to evaluate their learning and to make instruction-related decisions (Alberta Education, 2006; Baker, Chung & Delacruz, 2007; Campbell, 2006; Wiggins & McTighe, 1998).

Although assessment is done for many different reasons, the most common purposes are for formative or summative evaluation of student learning. In formative assessment, teachers assess student work to find out what students know and can do, learn about student strengths, and diagnose areas of difficulty in order to make decisions about next steps in remediation or direction forward. Formative assessment is primarily concerned with the quality of the students' learning vs. summative assessment which usually has the purpose of measuring student performance against standards (Angelo & Cross, 2003). Assessment standards can be "norm-referenced" where an individual's performance is measured against the performance of a group, or "criterion-referenced" where an individual's performance is measured against elements or criteria specific to the task (McNeil, 1996).

Assessment results are only estimates of any students' knowledge or skills, resting on "a triangle" of three pillars: "…a model of how students represent knowledge and develop competence in the subject domain, tasks or situations that allow one to observe students' performance, and an interpretation method for drawing inferences from the performance evidence … " (National Research Council, 2001, p. 2). Use of assessment results need to take the alignment of these points—learning theory, instructional activities, and assessment method—into consideration (Biggs, 1996).

Formats or methods of assessment include, but are not limited to: tests (e.g., multiple choice, true-false, short answer), learning logs (e.g., journals, portfolios), observations (e.g., anecdotal records, checklists), performance tasks (e.g., problem-solving, simulations, labs, presentations), projects (e.g., models, investigations), written reports (e.g., papers, scripts, stories), oral examinations (e.g., debate, thesis defense) and visual communications (e.g., storyboards, advertisements, video) (Alberta Assessment Consortium, 2005). Traditional assessment sits on a triangle of behaviorist learning theory with the acquisition of basic skills and knowledge and, thus, favors "testing" as the preferred assessment method. However, even when well designed, the "closed" and "single correct answer" nature of traditional test questions provide limited information for a teacher to see partial understandings and to diagnose where and why a student is experiencing problems. In addition, with limited affordances to reflect the context and complexity of real-life situations, traditional testing is inadequate for testing the acquisition of higher-order learning (Wiggins, 1990).

In contrast, the goals of modern assessment rest on a triangle of constructivism and the acquisition of higher-level thinking skills and competencies (Gulikers, Bastiaens & Kirschner, 2004) and, therefore, more "authentic" and "open-ended" assessment methods. Authentic assessment tasks require the application of knowledge or skills in situated contexts. Open-ended methods such as learning logs and projects, for example, and questioning techniques "…elicit a range of responses, from incorrect to simplistic to generalized…" (Leatham, Lawrence & Mewborn, 2005, p. 414) and "… often require students to explain their thinking and thus allow teachers to gain insights into their learning styles, the 'holes' in their understanding, the language they use to describe … ideas, and their interpretations of situations." (Moon & Schulman, 1995, p. 30). No one method is sufficient for all purposes, but all assessments "… should both inform and enhance student achievement" (National Research Council, 2001, p. 314).

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Assistive Technology

SEE ACCESSIBILITY and UNIVERSAL DESIGN FOR LEARNING

Asynchronous Communication

SEE INTERACTION

Attribution Theory

SEE ALSO MOTIVATION

Attribution theory describes how one factor, the learner's reason for the performance quality, affects the learner's future performance. It posits that a learner's explanation for his or her academic success or failure can affect the learner's motivation and performance (Weiner, 1985). Learners may explain their own performance with one of four conditions commonly identified in the literature: luck, task difficulty, ability, and effort which then affects their subsequent performance (Martin & Dowson, 2009). Attribution theory incorporates locus of control (i.e., to whom or to what does the learner attribute success or failure) either to internal factors over which the learner has control or to external factors over which the learner does not (Jonassen & Grabowski, 1993). Jonassen & Grabowski, who analyzed two decades of locus of control research, have concluded that learners with an internal locus of control may benefit more and more often from several instructional approaches (e.g., offering students many instructional options, or asking them to self-evaluate or to self-pace their instruction) than do learners with an external locus of control.

Others have investigated training to foster effort attributions which would lead to more internal, and less external, locus of control. Such attribution training has decreased college course failure rates when compared to a no training group (Haynes, et al., 2011). Similarly, learners who evaluated their own studying efforts after tests earned modestly better test scores than the group which limited their analyses to only how long they studied and when (Poelzer & Zeng, 2008). The authors suggest that the treatment had similar effect as attribution training since they had to plan future study efforts.

Learners who attribute their performance to factors over which they have control may be better able to persist and perform than if they attribute their academic success or failure to uncontrollable conditions, such as luck, task difficulty, or ability. Results of a correlational survey of 5,333 high school students suggest that their effort attributions motivate achievement, although self-report data introduced some self-serving bias (McClure, et al., 2011). Learners tend to explain their success in terms of their control of the situation, and their failure in terms of their lack of control. If learners believe they can complete an academic task successfully, then they are more likely to be able to do so. This is especially true if the learner's explanatory narrative is "if I study more or differently, I can be successful." This learner has control over how much effort to expend on the task and which strategy to use. If, on the other hand, learners believe that the cosmic forces are against them, why try? The conditions are uncontrollable.

Weiner (2004) suggests attribution is both intrapersonal and interpersonal. His social cognitive analysis explains interpersonal, that is learner motivation, and intrapersonal, that is observer motivation, through attribution theory. His expanded attribution theory describes motivation in the actor and in the observer.

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Audiovisual Instruction

SEE ALSO EDUCATIONAL MEDIA and GRAPHICS and VISUAL AND PICTORIAL LEARNING

Audiovisual instruction may be defined as instruction that involves the use of visual and/or auditory aids to facilitate learning (Gordon, 1961). Today these aids are often referred to as *instructional media,* the physical means via which instruction is presented to learners (Reiser & Gagne, 1983).

Interest in the use of visual aids to learning has been traced back at least as far as the first decade of the twentieth century, when educational films were first being produced (Saettler, 1990). During the same decade, and up through the early 1920s, bureaus of visual education and school museums, whose modern-day equivalent is the media center, were established in many large cities (Saettler, 1990). These units served to distribute visual instructional materials such as films, slides, and photographs to neighboring schools. With the increasingly easy availability of such materials, interest in what was then called *visual instruction* started to grow.

Formal definitions of visual instruction focused on the media that were used to present instruction. For example, one of the first textbooks on visual instruction defined it as "the enrichment of education through the 'seeing experience' [involving] the use of all types of visual aids such as … pictures, models, exhibits, charts, maps, graphs, stereographs, stereopticon slides, and motion pictures" (Dorris, 1928, p. 6).

During the late 1920s through the 1940s, as a result of advances in such media as sound recordings, radio broadcasting, and motion pictures with sound, the focus of the field shifted from visual instruction to *audiovisual instruction*. From the 1950s into the early 1960s, largely as a result of the initial enthusiasm educators had for the use of instructional television, interest in audiovisual instruction continued to grow (Saettler, 1990).

Starting in the early 1960s, the term "audiovisual instruction" started falling out of favor. For example, in 1963, a definition put forth by the major professional association for audiovisual instruction stated that the field was not simply about audiovisual aids. Instead the definition focused on the "messages which control the learning process" (p. 38) and discussed a series of steps for designing and using such messages (Ely, 1963). Several of these steps (e.g., planning, production, and utilization) are similar to those often described as part of the instructional design process (e.g., Dick, Carey, & Carey, 2009).

Currently, the term "audiovisual instruction" is rarely used; however, many professionals in the field focus much of their attention on the design, production, and use of audio and video instruction that is delivered by such media as computers, the Internet, and mobile devices.

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Also See Additional Resources for Further Information on this Subject

Authentic Activity

SEE ALSO ANCHORED INSTRUCTION and COMMUNITY OF PRACTICE and CONSTRUCTIVISM and CONSTRUCTIVIST APPROACH and PROBLEM-BASED LEARNING

The concept of authentic activity is associated with constructivism in which one of the keys dimensions of constructivist learning environments is authenticity. According to Herrington (2006), authentic activity is very similar to the work of experts in real life and involves close collaboration on ill-structured problems which may have diverse acceptable solutions (Bennett, Harper, & Hedberg, 2002). Brown, Collins, & Duguid (1989) define authentic activity as the ordinary practice of the culture with the characteristics of being coherent, meaningful, and purposeful. Furthermore, they argue that authentic activity is a central component of learning and "important for learners, because it is the only way they gain access to the standpoint that enables practitioners to act meaningfully and purposefully" (p. 36).

Cholewinski (2009) provides a graphic to illustrate the concept of authentic activity with a very broad theoretical perspective; it includes:

- A theoretical foundation (such as cognitive constructivism and social constructivism)
- Key instructional methods (such as project-based learning, anchored instruction, inquiry-based learning, collaborative learning, situated learning, and knowledge-building communities)
- Related activity concepts (including zone of proximal development, modeling, learner control, scaffolding, coaching, technology and media, and cognitive apprenticeship)

In teaching and learning practice, authentic activities can provide students with diverse and rich learning experiences to develop knowledge and skills, and allow them to apply them to real-life situations immediately. For schooling, the most popular examples of authentic activities include role-playing, simulations, and case studies. In authentic learning, students are required to draw on their own past experiences in authentic settings. The challenge is critical for learners to create a simulation of a real-life situation and collaboration is integral to problem solving. The typical focus of authentic learning is placed on real-world, complex problems and their solutions using role-playing exercises, problem-based activities, case studies, and participation in virtual communities of practice (Clayden, Desforges, Mills, & Rawson, 1994).

Recently, many organizations and professionals in educational technology have shown a great interest in authentic activity and its application in education. Herrington, Reeves, Oliver, & Woo (2002) explored ten characteristics of authentic activities and used authentic activity as a model for Web-based learning. In 2007, EDUCAUSE published a whitepaper with the title of *Authentic Learning for the twenty-first century: An Overview* which explores what constitutes authentic learning, how technology supports it, what makes it effective, and why it is important (Lombardi, 2007).

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Authentic Assessment

SEE ASSESSMENT

Avatar

SEE ALSO AGENT and DIGITAL GAME-BASED LEARNING and VIRTUAL WORLDS

An avatar is a digital representation of a user or player in a virtual environment through which the player interacts with the game software and other players (Steinkuehler, 2006; Yee, Bailenson, Urbanek, Chang, & Merget, 2007). The first thing a player must do when entering a virtual world is create an avatar, and a typical player used to spend hundreds of hours in developing the avatar (Castronova, 2001), although this time is now considerably reduced. The avatar can often take many shapes, from a reflection of the player to someone or something completely different, such as an animal or a fictional being (Wang & Hsu, 2009). Avatar character development continues as the player spends more time "in-world".

The relationship a player has with his or her own representation, the avatar, plays an important role on the immersive quality of virtual environments and multiplayer games (Dickey, 2007; Pence, 2007). According to Dickey (2007) "as players develop their characters, they are in a sense taking on a role" (p. 258). The avatar's appearance and skills are important to the player's social capital (Pence, 2007). Many residents spend more time in their virtual lives than in their real lives, "indeed so many hours that one can almost believe that many people do live there, wherever there is, and not in Earth" (Castronova, 2001, p.14).

Nonverbal and verbal behaviors of avatars are "governed by the same social norms as social interactions in the physical world" (Yee et al., 2007, p. 119). Along with the embodiment of an avatar it is the interactions between avatars that significantly impact the sense of presence the user experiences in the virtual world (Feldon & Kafai, 2008).

Whereas avatars are controlled by real people, computer-controlled digital beings are called bots. Typically bots are programed to perform as a simulated intelligence also known as artificial intelligence. Some bots can even learn as they interact with humans. Bots can look just like a human-controlled avatar; however it is usually easy to identify bots within a few minutes of interaction, as they tend to lack natural movement and communication skills.

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B

Back Channel Communication
SEE COMMUNICATION

Behaviorism
SEE ALSO INDIVIDUALIZED INSRUCTION and INSTRUCTIONAL DESIGN MODELS and PROGRAMED INSTRUCTION and REINFORCEMENT

Behaviorism refers collectively to several quite diverse bodies of thought in psychology (and philosophy) proposing that learning can best be understood by observing behaviors, rather than speculating about internal physiological events or hypothetical constructs such as the mind.

Early twentieth century proponents of a behaviorist perspective included Ivan Pavlov in Russia and John Watson and Edward Thorndike in the USA. In the mid-twentieth century B.F. Skinner contrasted his operationalization of behaviorist learning theory—operant conditioning—with earlier theories, which he dubbed classical conditioning. Those earlier theories were relevant to the study of involuntary reflexes which were under the control of preceding stimuli; Skinner studied *voluntary* behaviors that were strengthened or weakened depending on the *consequences* that followed. It is this latter school of thought, known as radical behaviorism that has had the greatest practical impact on theory and practice in educational technology (Burton, Moore & Magliaro, 2004; Driscoll, 2005).

Skinner discovered that by manipulating the variables of stimuli, responses, and consequences he could elicit quite complex new behaviors from laboratory animals (Ferster & Skinner, 1957). Other researchers found that humans, too, responded in similar ways.

A great many educational innovations can be attributed directly or indirectly to behaviorist influences. These innovative designs and the procedures used to instantiate them came to be viewed as "educational technology" (DeCecco, 1964). They are the following:

1. *Programed instruction*. Prompted by his own experiences as a parent, Skinner (1954) developed a mechanical device for interactive learning, popularly referred

to as a teaching machine. The pattern of stimuli, responses, and reinforcers built into teaching machines became known as programed instruction (PI). In the 1960s PI lessons in book format were published in great profusion, many using the Skinnerian framework and many using a variation, branching programing, in which learners were directed ahead or to remediation depending on their answers to embedded questions. Further, the design process for PI required proceduralizing the steps of analysis, design, and evaluation—one of the elements that eventually coalesced into the instructional systems design model.

2. *Programed tutoring*. Devised by Douglas Ellson, in programed tutoring a live person, often a peer learner, following prescribed procedures, leads a tutee through practice exercises, giving social reinforcers (e.g., a smile) for correct responses and hints when incorrect (Ellson, Barber, Engle, & Kampwerth, 1965).
3. *Computer-assisted instruction*. Early attempts to use computers to control instruction took place during the heyday of PI, and programers generally followed the response-reinforcement or branching formats already popularized in PI.
4. *Mastery Learning and Personalized System of Instruction*. Associated with Carroll (1963), Bloom (1971), and Block (1971), the Learning for Mastery school model divides subject matter into units, and students—alone or in groups—work through each unit, culminating in a mastery test on which students must succeed before moving to the next unit. A similar system, dubbed Personalized System of Instruction (PSI), was devised for use in higher education (Keller, 1968); it is the instructional model now used in most distance education.
5. *Learning contracts*. Based on Premack's (1965) principle that a high-probability activity can be used as a reinforcer for a low-probability activity (e.g., "If you complete the math worksheet you can play in the gymnasium"), a learning contract is an agreement that specifies what is expected of the student and what the consequences will be. Such "contingency contracts" are widely used in schools and therapeutic settings.

The contemporary incarnation of behaviorism is known as behavior analysis and is a thriving field with professional associations around the world and a large set of respected journals which continue to have high impact on applied psychology. Therapeutic programs derived from behavior analysis are widely viewed as the standard by which innovative treatments are measured.

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Blended Learning

SEE ALSO DISTANCE EDUCATION AND LEARNING and INTERACTION

When defining blended learning the crucial question is—what is being blended? In its most elemental form, blended learning is an instructional design where face-to-face and online (mediated) learning are thoughtfully fused in educationally meaningful ways (Garrison & Vaughan, 2008). To be clear, blending is more than layering or bolting on technology to traditional face-to-face learning experiences. The challenge and distinguishing feature is to purposely integrate face-to-face and online learning experiences in effective designs that capitalize on the modalities of information and communications technology (ICT) to achieve intended learning experiences.

While this is a useful starting point, operationally, there remains considerable complexity and ambiguity. Any number of things (media, context, approaches) may be appropriately blended, but at its core blended learning is about integrating synchronous and asynchronous communication in face-to-face and virtual environments (excluding the blending of asynchronous and synchronous communications media in fully online forms of distance education). Blended learning designs purposefully and creatively integrate synchronous free flowing, often spontaneous verbal communication with asynchronous reflective and precise written communication in face-to-face and virtual environments. The ambiguity arises when we attempt to clearly demark blended learning from pure face to face or fully online learning. The reality is that it is arbitrary to suggest precise maximums and minimums for what constitutes blended learning. This will become more problematic as the integration of technology in traditional on-campus classes grow and the purely face-to-face classroom experience fades.

Operationally the definition of blended learning must be seen as being fluid (Picciano & Dziuban, 2007). The distinguishing added value of blended learning is the enhancement of interaction and collaboration as well as extending this interaction across time and space, all of which is made possible through the effective integration of ICT. It is such principles that distinguish blended learning. At its highest level, blended learning designs are directed to support and sustain communities of inquiry. Consistent with this is the assumption that blended learning will fundamentally transform the structure and process of the educational experience through course and program (re)design (Garrison& Vaughan, 2008). As this occurs, blended learning may well dissolve as a useful term as most formal learning experiences will meet the definition of blended learning.

Synonymous terminology: hybrid; mixed-mode.

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Also See Additional Resources for Further Information on this Subject

Blog

SEE ALSO COMMUNITY OF PRACTICE and REALLY SIMPLE SYNDICATION and SOCIAL COMPUTING and TECHNOLOGICAL COMMUNICATION

At its most fundamental, a blog (or Web log) is a type of Web site that exhibits two key features: it is comprised of a series of text entries (posts) added in reverse chronological order, and it is easy to update and is usually updated frequently. Most commonly a blog is characterized as a personal journal that contains the author's opinions, observations, critiques, and experiences. The author of a blog is referred to as a "blogger," and the act of maintaining a blog is referred to as "blogging." Blog content may be personal, corporate, organizational, political, or educational.

Blogs have several important affordances related to self-expression, self-reflection, social interaction and support, and reading (Deng & Yuen, 2011). Specifically, an author can share a stream of blog content with a wide audience without restrictions or filters. While restrictions and filters may be imposed in certain contexts such as schools, the tradition of blogging emphasizes unfettered communication. The lack of constraint affords the potential to attract a large and diverse audience, and also assigns public and legal responsibilities on the author for what is written (McQueen, 2009) and invites cautions about the line between free speech and defamation (Ringmar, 2007; Winer, 2009).

Another significant affordance of blogs is conversation in the form of comments. Blog services permit authors to choose whether to allow readers to reply to a blog post, and whether replies from readers are reviewed and approved or rejected (moderated) by the author, or automatically approved without moderation. This affords the possibility of running commentary and dialogue between the author and readers, and among readers.

Blogs require minimal technical expertise of users, and this accessibility affords a public voice to large numbers of people who might otherwise avoid using technology. With relative ease, authors can write and edit text messages and add images and multimedia.

The audiences of blogs include casual readers who stumble across posts, deliberate readers who search for blog posts on particular topics, or who are referred to posts by others. Blogs also have subscribers—individuals who follow the content of particular blogs by registering with the blog or by adding the RSS (really simple syndication) feed of the blog to an aggregator or feed reader (a service that assembles into one location all of the posts of blogs to which a person subscribes).

Authors of blogs (bloggers) often use blogs as tools to promote informal, self-directed learning through acquisition and reflection (Park, Heo, & Lee, 2011). A blog is also frequently used to organize a community of practice and to promote collaboration (Byington, 2011). Andergassen, Behringer, Finlay, Gorra, and Moore (2009) observed that despite reports that blogs have a positive influence on learning through active knowledge construction and reflective writing in formal learning contexts, many students do not choose to blog informally, as they prefer direct online communication, and because of privacy concerns. Conversely, those who choose to blog informally are driven by intrinsic motivation factors.

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Bloom's Taxonomy

SEE LEARNING TYPES and TAXONOMY

Bot

SEE AVATAR

C

Case-Based Instruction
SEE LEARNING BY DOING

Case-Based Reasoning Theory
SEE LEARNING BY DOING

Cataloging
SEE INFORMATION CLASSIFICATION

Causal Learning
SEE GENERALITY

Cause Analysis
SEE ANALYSIS

Change
SEE ALSO CHANGE MODELS and INNOVATION and ORGANIZATIONAL CHANGE

Change, a fundamental process inherent to all dynamic systems, refers to transformation from one or a set of conditions to a different state. Change occurs over time and is therefore a process and not an event (Kaufman, Oakley-Brown, Watkins, & Leigh, 2003). Because "educational technologists and instructional designers are interested in facilitating and improving learning and performance" they take "the notion of change seriously" (Spector, 2010, p. 6). For such educators, the smallest unit of change analysis is the individual learner. However, change can also be analyzed as an intra-institutional phenomenon or, more broadly, as an inter-institutional phenomenon. A persisting individual "change in performance or performance potential" defines learning (Driscoll, 2005, p. 9). The well-researched Concerns-Based-Adoption-Model (CBAM) (Hall & Hord, 2006) describes how an individual's behaviors change toward an innovation as their knowledge and experience with it builds. In these contexts change occurs as an intra-individual phenomenon (Driscoll, 2005), but change may also be analyzed as an intra- or inter-institutional systemic phenomenon.

Change, not easily defined as a concept for understanding institutions, has been described as a phenomenon within an organization, between an organization and others, or as other's perceptions of an organization (Cox, 2010). Newer change theories describe it as a series of nonlinear processes highly influenced by context and the inter-dependent components of a system (Sahlberg, 2002). One systemic model analyzes how change resistance complements the opposing institutionalizing forces to affect change outcomes in educational organizations (Flores-Kastanis, 2009). At the turn of the century a journal devoted to "change thinking and research on educational change … evidence and research knowledge on change patterns and their implications, and … its moral and political purposes" (Hargreaves, 2000, p. 3) reflected a sustained scholarly interest in the topic. Change continues to be an urgent, timely, and important topic for scholarly studies of both learners (see Ifenthaler & Seel, 2011) and of educational systems (see Borgemenke, Blanton, Kirkland, & Woody, 2012).

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Change Models
SEE ALSO CHANGE and INNOVATION and ORGANIZATIONAL CHANGE

Change models are theoretical constructs that describe how change occurs (Rogers & Rogers, 2003) or prescribe how planned change occurs (Hord, Rutherford, Huling-Austin, & Hall, 1998). In either case, change is a process not an event (Kaufman, Oakley-Brown, Watkins, & Leigh, 2003). Change models offer an explanation for how people in a social system intentionally alter how they work, teach, or learn. Change models account for how people, communications, and learning influence an innovation. In the instructional design and technology field the concerns are typically with innovative learning and teaching technologies. They describe how a group incorporates an innovation into routine practice. Change within any social system is about people being willing and able to work differently and incorporate the desired organizational innovations.

The social activity surrounding an educational innovation fuels the pace of adoption and drives the attempts to explain and plan for the innovation. In his monograph describing seven preeminent education change models, Ellsworth (2000) summarizes planned change history during the last half of the twentieth century. Technological innovation has been accelerating educational innovation. Each model Ellsworth (2000) describes frames change in terms of a different change communication component. The seven models he highlights and their key elements are the following:

- Ely's Conditions of Change (environment)
- Fullan & Stiegelbauer's New Meaning of Educational Change (change agent)
- Hall & Associates' Concerns-Based Adoption Model (adopter)
- Havelock's Change Agent's Guide (change process)
- Reigeluth & Garfinkle's Systemic Change in Education (system)
- Roger's Diffusion of Innovation (diffusion)
- Zaltman & Duncan's Strategies for Planned Change (resistance)

Two of these models show their inherent diversity. Ely's Conditions of Change model describes factors which affect change in social systems, including rewards, time, resources, knowledge, skills, participation, commitment, and leadership.

The last five items are human characteristics or traits within the social system in which it was introduced (Ellsworth, 2000). The Concerns-Based-Adoption model (Hord et al., 1998) approaches change as a training and learner readiness assessment problem. Innovation adoptees report their concerns about the innovation and classify these concerns into one of seven adoption levels corresponding to specific training needs.

Despite the large number of change models, some still call for models specifically for education (Hayward & Spencer, 2010; Wedell, 2009) and training since much of the research addresses changing other types of human behavior, such as health habits or social interactions or professional development (Dobbs, 2004; Ebert & Crippen, 2010). The Dialectic Model of Change which does emphasize education in particular offers an entirely different view. The Dialectic Model of Change identifies two social practices in every educational setting that have opposite and complementary purposes, institutionalization and contestation (Flores-Kastanis, 2009). The former "refer[s] to the process by which social practices and arrangements become sufficiently regular and continuous in a given context to be considered as relatively permanent features of the setting in which they take place" (Flores-Kastanis, 2009, p. 393), and the latter, a euphemistic term for change resistance. The participatory action research approach supports educational change by supporting both aspects. Alternatively, educational change may be a function of community organization efforts that spring from community organizing models. Although conservative educational politics reigned in the USA from 2000 to 2008, paradoxically and simultaneously, community organizing for educational change grew quickly (Shirley, 2009).

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Change, Resistance to
SEE CHANGE

Change Strategies
SEE CHANGE

Children's Internet Protection Act
SEE ALSO ETHICS

The Children's Internet Protection Act (CIPA) was enacted by Congress and in 2001 the Federal Communications Commission issued rules implementing it. The law applies to all schools and libraries that receive federal funding. The intent of the law is to protect children from offensive material obtained from the Internet. Schools and libraries must take an active role to prevent offensive material from reaching the children. Schools and libraries must construct a:

> …safety policy addressing: (a) access by minors to inappropriate matter on the Internet; (b) the safety and security of minors when using electronic mail, chat rooms, and other forms of direct electronic communications; (c) unauthorized access, including so-called "hacking," and other unlawful activities by minors online; (d) unauthorized disclosure, use, and dissemination of personal information regarding minors; and (e) measures restricting minors' access to materials harmful to them (Federal Communications Commission, 2011).

Typically schools and libraries will provide this protection through a proxy server that monitors all traffic into and out of the institution and actively blocks all offensive traffic. An adult may unblock any transmission of material if it can be shown that the use of material is for "bona fide research or any other lawful purpose" (Federal Communications Commission, 2011). This act does not affect schools or libraries that receive e-Rate funding for only telecommunications, such as telephone service.

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Children's Online Privacy Protection Act
SEE ALSO ETHICS

The Children's Online Privacy Protection Act protects the rights of children under the age of 13 when they participate in online forums, discussion boards, online surveys or any other online vehicle that collects information from children. The act states that the collector of the information must conspicuously post a notice that personal information is collected (Cannon, 2000). Personal information is defined by the act as name, physical address, Internet address, phone number, social security number, and any other information that permits physical or online contacting of the individual.

The act "provides safeguards to protect the online privacy of children under age 13" (Aidman, 2000, p. 46). Collectors of this information must obtain the permission of the parent or guardian. The collector must inform the parent of the reasons for collecting the information and how the information will be used and disseminated.

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Child-Safe Environments
SEE CHILDREN'S INTERNET PROTECTION ACT and CHILDREN'S ONLINE PRIVACY PROTECTION ACT

Chunking
SEE ALSO COGNITIVE STRATEGIES and INFORMATION PROCESSING THEORY and MEMORY and MESSAGE DESIGN

Chunking is a micro-level strategy for knowledge- and comprehension-level learning (remembering and understanding) in Bloom's taxonomy, which is highly associated with memory (Bloom, Engelhart, Furst, Hill & Krathwohl, 1956; Krathwohl, 2002). Cowan (2001) defines a chunk as "a collection of concepts that have strong associations to one another and much weaker associations to other chunks concurrently in use" (p. 89). Therefore, chunking refers to breaking content into smaller pieces or grouping individual elements into larger elements in order to facilitate learners' information processing. Assuming that learning occurs through schema acquisition, chunking can increase the amount of information that can be processed in working memory (Sweller, 1994).

The notion of chunking was first devised based on Miller's (1956) seminal work on short-term memory. It has been well known since Miller (1956) that short-term memory is limited in capacity, in contrast to long-term memory. Miller (1956) revealed that short-term memory can receive, process, and hold more information by recoding information into meaningful chunks, and that short-term memory is limited to about seven items. Later, other researchers found that the capacity of short-term memory can be as small as four items, and Cowan (2001) has summarized the research findings and conditions under which the capacity is limited to four chunks.

Recently, research has been focused on reconciling the equivocal results on capacity by researching chunking more completely. For example, after multiple experiments, Mathy and Feldman (2011) concluded that four items is indeed the limit when the information consists of units compressed into a single item, and seven is the limit when the information is not compressed. The limits on the capacity of short-term memory have been widely used in combination with cognitive load theory for multimedia instructional designs and game designs (Chandler & Sweller, 1991; Sweller, 1994; Van Merriënboer, Kirschner, & Kester, 2003).

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Cloud Community
SEE COMMUNITY OF PRACTICE

Cloud Computing
SEE ALSO WEB 2.0

Cloud computing has been defined by the National Institute of Standards and Technology (NIST) as "a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction" (NIST, 2011, p. 2). Five essential elements for cloud models have been identified as: (1) on-demand self-service, (2) broad network access, (3) resource pooling, (4) rapid elasticity, and (5) measured service (NIST, 2011).

The "cloud" is a term that describes very large, distributed, and networked data centers that are used to store data and run applications (Johnson, Adams, & Haywood, 2011). "Cloud-based" applications are typically accessed by end users through a browser and require Internet connectivity because they run on computers in the cloud's data centers. Examples of common cloud-based applications include Google for e-mail and document creation and sharing, Flickr for photo storage and sharing, and YouTube for video storage and sharing. Cloud computing is the foundation for most, if not all, Web 2.0 applications that allow users to contribute content and interact with others around their contributions.

While cloud computing has broad application beyond education, its potential for impacting K-12 and higher education sectors has been specifically identified (Katz, 2008; Johnson, Adams, & Cummins, 2012; Johnson, Smith, & Haywood, 2011). Greenhow, Robelia, & Hughes (2009) noted that cloud computing will likely have the effect of intensifying participatory and creative practices in education. There is already preliminary evidence that cloud-based resources are becoming a part of students' academic lives (Smith & Caruso, 2010). Additionally, when applications run in the cloud, less computing power is required on the end users device making smaller mobile devices with limited storage space viable tools for educational purposes. Cloud computing also increases the ease with which distributed collaboration and communication can occur, thus supporting the rapid growth of the online learning sector.

Many educational institutions are beginning to use cloud-based computing applications because of a significant projected reduction in IT costs (Johnson, Adams, & Cummins, 2012; Johnson, Smith, & Haywood, 2011). Sultan (2010) has also noted the positive effect that cloud computing has had on advancing education in developing countries because of reduced costs and increased access to quality resources. While there are many benefits to cloud computing, there are still many challenges within the paradigm that are being worked on including data confidentiality/security, data transfer bottle necks, and performance unpredictability (Armbrust, et al., 2010).

Core research in cloud computing is happening in the domain of computer science. However, cloud computing is an enabling technology that affects access, development cost, sharing, social networking, Web 2.0 tools, and many other issues that are of concern to researchers in educational technology.

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Codes of Ethics

SEE ETHICS

Cognitive Apprenticeship

SEE ALSO COMMUNITY OF PRACTICE and SCAFFOLDING and SITUATED COGNITION

Apprenticeship allows a learner to observe processes or methods used by an expert in order to learn an activity. Cognitive apprenticeship differs from traditional apprenticeship in that the activity being learned is less about a physical skill and more about a cognitive skill. “Cognitive apprenticeship is a model of instruction that works to make thinking visible" (Collins, Brown, & Holum, 1991, p. 6). Collins et al. (1991) described three significant distinctions regarding traditional apprenticeship and cognitive apprenticeship. In cognitive apprenticeship: (1) cognitive and metacognitive processes must be made visible to the learner and instructor so they can be observed, enacted, and practiced; (2) the activity should be situated in authentic contexts that make sense to the learner; and (3) a variety of situations and tasks should be presented along with opportunities for the learner to reflect on and verbalize the common elements to help enhance transfer of learning.

Collins et al. (1991) developed a framework of cognitive apprenticeship that included four dimensions: content, method, sequence, and sociology. Within each of these four dimensions are characteristics to consider when creating or evaluating a cognitive apprenticeship. Content is comprised of domain knowledge, heuristic strategies, control strategies (metacognitive strategies), and learning strategies. Method is comprised of modeling, coaching, scaffolding, articulation, reflection, and exploration. Sequence includes global before local skills, increasing complexity, and increasing diversity. Finally, sociology contains situated learning, community of practice, intrinsic motivation, and cooperation.

Recently, cognitive apprenticeship research has included situated learning, scaffolding, and community of practice (Dennen & Burner, 2008). Scholars are now examining the effects of intentionally designing situations that include situated learning and scaffolding, as well as deliberately trying to create communities of practice.

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Also See Additional Resources for Further Information on this Subject

Cognitive Development Theory

SEE COGNITIVE DISSONANCE THEORY

Cognitive Dissonance Theory

SEE ALSO SCHEMA THEORY

Cognitive dissonance theory can be defined as the perceived gap a learner has between what he or she knows and new information. The term grew from literature in psychology and has been used to define an uncomfortable internal state occurring when new information conflicts with commonly held beliefs (Festinger, 1957). As an example, imagine being presented with evidence that the Earth revolves around the sun when your understanding is that the sun revolves around the Earth. From the educational perspective, Piaget (1975) saw cognitive dissonance as a means to facilitate the cognitive processes of accommodation and assimilation, which were critical to his ideas of knowledge development.

Piaget (1975) saw what he termed cognitive disequilibrium as an opportunity for cognitive growth. One of the assumptions of Piaget's Cognitive Development Theory states that when learners experience cognitive disequilibrium, their cognitive systems engage in a process of accommodation and assimilation as the new material is integrated into their existing schema. This dissonance is seen as an essential trigger for the learning process resulting in learners that are engaged in problem-solving activities and/or trial-and-error learning. As an added benefit to the learning process, the intrinsically motivational aspects of working to resolve cognitive dissonance create an environment where learners are continually exposed to content-relevant information facilitating deeper processing.

While the psychological perspective conceptualizes cognitive dissonance as something that must be resolved in an individual, those examining it from an educational perspective see it as an opportunity to foster schema construction and design opportunities for the correct level of dissonance to promote the development of knowledge. For designers, the correct level of dissonance can be determined by understanding an individual's Zone of Proximal Development (ZPD) (Vygotsky, 1978). ZPD is defined as the space where learners can resolve dissonance with the support of educational scaffolding.

The process of knowledge acquisition involves integrating new knowledge with existing schema. Allowing learners to be in a state of cognitive dissonance is ideal for new learning as it gives learners a process for integration through assimilation and accommodation. The intrinsic human need to move from disequilibrium to equilibrium creates a constant process of examining and re-examining information until a satisfactory solution is reached. One key consideration in the design of these environments is to understand the relationship between the level of cognitive dissonance and the motivation to solve problems. Learners are quickly bored with a level of dissonance that is too easily resolved, but on the other hand can be frustrated with a level of dissonance that is too high.

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Cognitive Learning Theory
SEE ALSO CONDITIONS OF LEARNING and INFORMATION PROCESSING THEORY and SCHEMA THEORY

Cognitive learning theory is about occurrences in the mind of the learner. Cognitive learning theory is influenced by cognitive psychology principles, which include how individuals obtain, construct, process, analyze, organize, store, retrieve, and apply information. According to Smith and Ragan (2005), "cognitive learning theory focuses on explaining the development of cognitive structures, processes, and representations that mediate between instruction and learning" (p. 26). Cognitive learning theory can include concepts such as linking new information to old knowledge, schema theory, theories of transfer, artificial intelligence, computer simulations, information processing theory, and situated cognition theory, among others.

"There is no single universally accepted 'cognitive theory' but rather a collection of influential frameworks emphasizing different aspects of cognition" (Morrison, Ross, & Kemp, 2007, p. 350). Cognitive theorists such as Ausubel (1963), Bruner (1966), and Gagné (1985) have each described different aspects of cognition. Ausubel is known for rote learning versus meaningful learning, subsumption theory, and advance organizers. Bruner is known for discovery learning and constructivism. Gagné proposed learning outcomes (for the cognitive domain: verbal information, intellectual skills, and cognitive strategies) and the events of instruction as a series of phases. Although different perspectives, they similarly included the value of the learner's internal mental (cognitive) process. Some of those cognitive processes include encoding, storage, memory, and retrieval. Encoding is taking new information and modifying it in some way (perhaps by relating it to existing knowledge). Storage is the acquisition of new knowledge, which is then processed into memory (sensory memory, working memory, or long-term memory). Memory is the ability to mentally retain information learned over a period of time. Retrieval is remembering previously stored information (Ormrod, 2010).

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Also See Additional Resources for Further Information on this Subject

Cognitive Load

SEE ALSO COGNITIVE PROCESSES and MESSAGE DESIGN and MUTI-CHANNEL INSTRUCTION

Cognitive load (CL) refers to the thought processes required for working memory to engage in learning activity (Sweller, 1994). It is the key concept in learning and instruction theory that describes a human cognitive architecture model with important instructional design implications (Kalyuga, 2011). CL theory assumes that learning processes are a function of working memory activities conducted with limited capacity and duration (Kalyuga, 2011). If learning processes exceed working memory capacity, memory overloads and inhibits learning. More specifically, cognitive load theory argues that instructional design must account for the limitations of the human cognitive architecture to avoid unnecessarily overloading the critical cognitive constraint, a learner's working memory (Schnotz & Kurschnere, 2007).

Intrinsic and germane CL, difficult to differentiate, arguably may be considered as one (Kalyuga, 2011). Intrinsic CL entails thought processes directed toward learning content or skills where as extraneous CL is the cognitive effort expended on negotiating the instructional format or media. For example, thought processes directed toward learning the parts of speech would be intrinsic CL and the thought processes directed toward accessing and navigating the computer-based instructional program for learning the parts of speech would be extraneous CL. Therefore extraneous CL is a function of element interactivity that can be eliminated (Paas, van Gog, & Sweller, 2010).

Instructional design implications are presented in a wealth of studies investigating how to reduce extraneous and increase intrinsic or germane cognitive load (Paas, Renkl, & Sweller 2003; Sweller, 1994; van Merriënboer & Sweller 2005). A learning activity with assignment requirements in two different documents or on two different Web pages inherently burdens the learner with extraneous CL either because the learner has to compare the two sets of instructions to identify differences or to confirm the differences. Either way, moving between two locations to confirm, reconcile or complete assignment instructions engenders extraneous CL.

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Cognitive Processes

SEE ALSO COGNITIVE LOAD and GENERATIVE AND SUPPLANTIVE INSTRUCTIONAL STRATEGIES

Cognitive processes are the mental activities one undertakes while learning. Typically these activities occur in the working memory. Mental effort, an aspect of cognitive load, refers to the cognitive capacity allocated to a task and is measured while participants are working on a task (Paas, Tuovinen, Tabbers, & Van Gerven, 2003). Therefore, cognitive processing, the term common to information processing learning theories (Halpern, Lamon, Donaghey, & Brewer, 2002), refers to mental effort during learning. Some examples of cognitive processes would include problem-solving, evaluating, analyzing, comparing, and any other mental activities.

Instructional interventions to change cognitive processes may be measured with effort, traditionally as self-reports, but they also should be measured with performance criteria. Self-report CL rating scale techniques have assumed that people are able to judge their cognitive processes (Paas, Tuovinen, Tabbers, & Van Gerven, 2003) although other measures have been suggested (DeLeeuw & Mayer, 2008). More recently functional magnetic resonance imaging (fMRI), a hemodynamic method can unambiguously identify the anatomical location of brain networks supporting the different processes of working memory under different cognitive load effects examine (Clark & Clark, 2010).

Cognitive load, cognitive processes, and mental effort have generated recent increased educator interest. Between 1986 and 2000, 15 published refereed journal articles were assigned the ERIC subject heading cognitive processes but since 2000, over 6,000 are in the category—1,400 last year alone. Since 2008, 94 EBSCO ERIC entries identified cognitive processes in the text and cognitive load in the abstract.

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Cognitive Strategies

SEE ALSO ADVANCE ORGANIZERS and CHUNKING and ELABORATION STRATEGIES and MNEMONIC and REPETITION

Cognitive strategies are mental techniques that "facilitate the storage and retrieval of information" (Richey, Klein, & Tracey, 2011, p. 59). According to Gagné (1974), a learner "uses cognitive strategies in thinking about what he has learned and in solving problems. Cognitive strategies are ways the learner has of managing the processes of learning (as well as retention and thinking)" (p. 64). Cognitive strategies can be used unconsciously (more automatically) or purposefully. The more automatic a strategy is, the less the cognitive load. Users need to not only know how to use a strategy, but also recognize when to use that strategy. Metacognition (knowledge about one's own thought processes) also can play a role in using cognitive strategies effectively.

Cognitive strategies can be learned both formally and informally. "Learners may arrive at these strategies through their own trial-and-error experiences, or they may be explicitly taught strategies that have proven effective with other learners" (Driscoll, 2005, p. 362). Gagné (1974) believed that a learner's ability to think and learn could be enhanced by formal education on cognitive strategies. Gagné (1974) has discussed five domains of learning: motor skills, verbal information, intellectual skills, cognitive strategies, and attitudes. Some examples of cognitive strategies are chunking, rehearsal, elaboration, mnemonics, advance organizers, and imagery.

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Also See Additional Resources for Further Information on this Subject

Cognitive Style

SEE FIELD DEPENDENCE AND INDEPENDENCE and LEARNER CHARACTERISTICS AND TRAITS

Cognitive Task Analysis

SEE ANALYSIS

Cognitive Tools

SEE ALSO CULTURAL HISTORICAL ACTIVITY THEORY and TECNOLOGY-ENABLED LEARNING

Cognitive tools, which refer to learning with technology as opposed to learning from technology, are developed when information technology is used to facilitate learning with the perspective of cognitive science. This concept is drawn from the perspective of socio-cultural psychology. Activity theory provides rich resources for the development of cognitive tools. According to activity theory, the powerful cognitive tools evolved culturally as Vygotsky (1978) argues that culture provides the child cognitive tools for development. Galperin develops Vygotsky's idea that teaching and learning plays a key role in mental development by providing culturally evolved cognitive tools which, once internalized by the child, mediate and advance the child's mental functioning (Arievitch & Stetsenko, 2000, p. 57).

Generally, cognitive tools are computer applications that enable learners to represent, share and reflect what they have learned. Jonassen (1992) defines cognitive tools as "generalizable tools that can facilitate cognitive processing" (p. 2) and later argues that "technologies, from the ecological perspective of Gibson (1979), afford the most meaningful thinking when used as tools" (Jonassen, 1994, p. 5). Salomon (1993) argues that when learning with technology, rather than learning from technology, technology will be transformed as cognitive tools and works as intellectual partners for learners, and learning will be facilitated. Lajoie & Azevedo (1993) summarizes that cognitive tools can benefit learners by serving the functions as follows: support cognitive processes, share the cognitive load, allow the learners to engage in cognitive activities, and generate and test hypotheses in the context of problem solving.

For schooling, one of the most popular cognitive tools is the computer. By using computers as mindtools, we use technologies as knowledge construction tools that support, guide, and extend the thinking processes of the learners (Derry, 1990). In teaching and learning practice, the cognitive tools include diverse forms of reasoning and argumentation. These tools include databases, spreadsheets, semantic networking programs, experts systems, system modeling tools, microworlds, hypermedia authoring tools, virtual reality tools, computer conferencing systems, and social network systems.

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Collaborative Learning

SEE ALSO COMMUNITY OF PRACTICE and DISTRIBUTED COGNITION and LEARNER-CENTERED INSTRUCTION and PROJECT-BASED LEARNING

Collaborative learning is broadly defined as a situation in which two or more people attempt to learn together (Dillenbourg, 1999) or to accomplish shared goals (Johnson & Johnson, 1996). Collaborative learning is rooted in Vygotsky's

(1978, 1986) sociocultural theory which posits that knowledge is developed by one's interaction with one's surrounding culture and society.

Characteristics of effective collaborative learning include positive interdependence among members, group and individual accountability, interpersonal skills, the ability to self-monitor, ensure consistent progress and discontinue patterns of behavior that impede the progress (Johnson & Johnson, 1996). Salomon (1993) described two kinds of distributed cognitions in collaboration: off-load and shared. He argued that shared cognitions are more likely to yield advances in individual competencies, while off-load reduces individuals' opportunities to learn. Dede (1990) attributes the effectiveness of collaborative learning to the active construction of knowledge, exposure to different models for problem solving and interaction, and motivating feedback shared among students.

Research in collaborative learning has been across a wide variety of fields, including the learning sciences, organizational learning, social, cognitive, developmental, and educational psychology, educational technology, instructional design, socio-cultural studies, and computer-supported collaborative learning (Puntambekar, Erkens, & Hmelo-Silver, 2011). Some seminal works include the situated learning (Brown, Collins, & Duguid, 1989), the development of communities of practice in workplace settings (Lave & Wenger, 1991; Wenger, 1998), and the development of Computer Supported Collaborative Learning concepts such as knowledge-building communities, knowledge-building discourse, intentional learning, and expert processes (Scardamalia & Bereiter, 1994).

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Color

SEE PRODUCTION and VISUAL MESSAGE DESIGN

Communication

SEE ALSO COMMUNICATION MAPPING and COMMUNICATION THEORY AND MODELS and GRAPHICS and MATHEMATICAL MODEL OF COMMUNICATION and SEMIOTICS and SOCIAL COMPUTING and TECHNOLOGICAL COMMUNICATION

Communication is the activity of conveying information. Communication has been derived from the Latin word "communis," meaning to share. Communication requires a sender, a message, and an intended recipient, although the receiver need not be present or aware of the sender's intent to communicate at the time of communication; thus communication can occur across vast distances in time and space. The communication process is complete once the receiver has understood the message of the sender. Feedback is critical to effective communication between parties (Berko, 2007).

Visual communication is the communication of ideas through the visual display of information. Primarily associated with two dimensional images, it includes art, signs, photography, typography, drawing fundamentals, color and electronic resources. Visual communication most often refers to photography, television, film, advertising drawing, and illustration (Smith, 2005). Recent research in the field has focused on Web design and graphically oriented usability. It is part of what a graphic designer does to communicate visually with the audience (Jamieson, 2007).

Unified communications (UC) is the integration of real-time communication services such as instant messaging (chat), presence information, telephony (including IP telephony), video conferencing, data sharing (including Web-connected electronic whiteboards or interactive white boards), call control and speech recognition with non-real-time communication services such as unified messaging (integrated voicemail, e-mail, SMS, and fax). Unified communications can encompass other forms of communications such as Internet Protocol Television (IPTV) and Digital Signage Communications. UC allows an individual to send a message on one medium and receive the same communication on another medium.

Backchannel communication is a secondary electronic conversation that takes place at the same time as a conference session, lecture, or instructor-led learning activity. Backchannel communications uses a digital infrastructure such as wireless connectivity with a growing range of wireless devices and the use of a chat tool or Twitter to discuss a lecture. These background conversations are being used in instruction as a formal part of lecture interaction where speakers integrate questions and comments adding to the formal class as feedback, or may be masked and not part of the formal class. "Whether the backchannel exists as a spontaneous chat among a few audience members or as an audience-wide discourse displayed as text on a screen for common participation, the allure is its immediacy as a real-time conversation in parallel with the formal presentation"(Educause, para 1, 2010). Alternatively, backchannel activity can function as unsanctioned discussion, independent of instructor participation or awareness. Some examples of backchannel tools including Google Moderator, Google Wave, instant messaging, Twitter, chat, and wikis. Backchannel communication outside of course structure is useful for communicating about content (direct) and developing social bonds (indirect) (Kearns & Frey, 2010).

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Communication Mapping

SEE ALSO COMMUNICATION and SOCIAL COMPUTING and TECHNOLOGICAL COMMUNICATION

Communication mapping is an approach to understanding what we do when we are utilizing and interacting with Web sites; it seeks to support our efforts to improve communication. The primary purpose of communication mapping is to highlight where communication needs to be improved, and find the effective guidelines for future design decisions. Through communication mapping we can develop an understanding of people's social networks and their motivation for using one communication tool over another. Though the outcomes of communication mapping could be a topographic map or a schematic map, the most efficient approach is a mixture of both.

The power of communication mapping is making invisible complex and significant relationships in a social network visible. Borrowing from Kress & van Leeuwen's (1996) approach to visual analysis, Turnbull's (1989) understanding of the map, and Latour's (1990) understanding of how visuals work in social contexts, Propen (2007) develops an analytical approach to studying communication maps as powerful visual, rhetorical objects. Paul Adams (2007), the user experience researcher of Google, proposes that the process of communication mapping has several steps, including the mapping of:

- People and groups
- Tools
- Event organization
- Sharing of content
- Motivations and perceptions
- Actual recent behavior

The aim of the mapping method employed is to use people's spatial memory to build up a picture of their social networks, illustrating both individual and group interactions.

Evans & Dansereau (1991) propose that communication maps provide details of an approach designed to improve the thinking processes involved in generating and receiving communication in the learning process. If communication mapping is used in learning research, it could help us understand what relationships each learner has in a group and how they communicate with the people around them. Brown & Duguid (1991) have discussed the role of communication mapping in organizational learning and argued that it is an effective way to build the community of practice in organizational learning, thus making it easier for people to get to know and accept those with whom they work most closely. For instructional technology professionals, the communication mapping approach could be used to design engaging communication tools that support or reinforce key messages or concepts in learning with technology.

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Communication Theory and Models

SEE ALSO CONSTRUCTIVISM and INTERACTION and MATHEMATICAL MODEL OF COMMUNICATION

There are many varieties of communication theory, but the type which is most pertinent to this field is concerned with the role of communication in the teaching and learning processes. However, these views of communication have evolved over time. Initially, communication was seen as "information passed from one place to another" (Miller, 1951, p.6). This gave rise to the dominance of the Shannon-Weaver model which portrayed communication as the passage of a message from a source to a receiver flowing through a specific channel and being impacted by external noise. (See The Mathematical Model of Communication for a recounting of how this model began.)

The emphasis on message transmission aligned closely with behavioral views of communication which were dominant in the 1960s. Here communication was seen primarily as a stimulus–response situation. A prime example of this orientation was Berlo's SMCR Model of Communication. The key elements of this model were the source, the message, the channel, and the receiver; Berlo (1960) identified the components of each. He saw the channel not as a physical transmitter of message as had Shannon and Weaver, but viewed them "in light of the human sense that would be used to decode the message" (Januszewski, 2001, p. 30). This reflected the role of the various audio-visual devices used to deliver instruction. In addition, Berlo emphasized the role of feedback in the communication process (i.e., the rewarding or punishing consequences of the message and one's response to it).

Communication, however, was not always seen as passing information from one place to another. Gerbner presented a view of it as a social process, as "interaction through messages" (Gerbner as cited in Heath & Bryant, 2000, p. 47). This point-of-view was reflected in Schramm's (1954) nonlinear model showing communication to be a constant and dynamic process. Senders and receivers actually operate at the same time and messages are interpreted in light of one's background and not simply decoded (Richey, Klein & Tracey, 2011).

This model of communication is closer to the constructivist model of Campos (2007). His Ecologies of Meaning Model presents communication as being a matter of sharing meaning among active participants. Campos (2007) defines communication as "a biological mechanism that enables the subject to make sense of himself or herself and of the outside world" (p. 396). Thus, communication is not a matter of delivering meaning, but of cocreating meaning based upon a mutual understanding of the world and the social environment.

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Community of Practice

SEE ALSO AUTHENTIC ACTIVITY and BLOG and COLLABORATIVE LEARNING and CONSTRUCTIVISM and SITUATED COGNITION and TECHNOLOGY-ENABLED LEARNING

Social anthropologist Jean Lave and social learning theorist Etienne Wenger first introduced the term community of practice (CoP) in 1991 to describe a group of individuals who share similar interests and through interaction and activities collectively develop new practices and knowledge. Lave and Wenger (1991, p. 47) described a CoP as "a set of relations among persons, activity and world, over time and in relation with other tangential and overlapping communities of practice."

CoPs consist of three essential elements: domain, community, and practice (Lave & Wenger, 1991). The domain focuses on a shared interest that relates to members' interests and provides the community value and purpose. Members' shared interest provides the motivation to discuss and share what is most important to the community and guides the way knowledge is organized. The knowledge domain is the center of gravity though its boundaries are permeable due to shifts in member focus. Over time, they develop a unique perspective on their topic as well as a body of common knowledge, practices, and approaches.

Wenger, McDermott and Snyder (2002) define community as a group of individuals who share experiences, learn together, and engage in regular interaction and knowledge sharing activities relevant to their domain. The community is the social fabric of learning where mutual respect, goodwill, trust, and communal identity are intertwined to build interpersonal relationships that promote a sense of belonging. Bender and Kruger (1982, p. 7) suggest the following about community:

> …community involves a limited number of people in somewhat restricted social space or network held together by shared understandings and a sense of obligation. Individuals are bound together by affective or emotional ties rather than perception of individual self-interest. There is a 'we-ness' in a community; one is a member.

The third element, practice, is the engine that drives knowledge, fuels critical reflection, and fosters social identity. "Practice denotes a set of socially defined ways of doing things in a specific domain: a set of common approaches and shared standards that create a basis for action, communication, problem solving, performance and accountability" (Wenger, McDermott, & Synder, 2002, p. 38). Practice is steeped in the past however, directed toward the future. Members share real-world experiences, challenges, stories, tools, and techniques to build and apply new knowledge. Membership implies a level of competence of common knowledge as the foundation for which members are able to build knowledge and effectively work together. It is important for members to share implicit and explicit knowledge and experiences so that individual members construct their own knowledge. Lave and Wenger suggests the learning that occurred in these CoPs is a form of "socialization into a community, where the newcomer gradually becomes a legitimate member of the community by learning the practice, language and conventions of the community through interaction with its established members" (Kimble & Hildreth, 2005, p. 3).

Bender viewed location as a concern for community members; however, today's technological advances have broken down the requirement of locality. Daniel & Schwier's (2008) virtual learning community model for the design of distributed communities explores ways to facilitate the connectedness of members to acquire meaningful information and knowledge. Future trends into the research and practice focuses on virtual communities, social network analysis, and how information and knowledge flows within the community.

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Comparison and Contrast

Comparison and contrast is a micro-level instructional strategy that is useful for the comprehension (understanding) level of Bloom's Taxonomy (Bloom, Engelhart, Furst, Hill & Krathwohl, 1956; Krathwohl, 2002).

There are two major kinds of understanding: understanding concepts and understanding principles or causal models (Reigeluth, 1999a). Comparison and contrast is generally utilized for understanding concepts. Ausubel (1968) pointed out that understanding could occur when the content is potentially meaningful and when the learner can relate the content in a meaningful way to prior knowledge.

In order to understand concepts, appropriate links should be made within important dimensions of understanding (Driscoll, 2000; Reigeluth, 1999b). The major dimension where the comparison and contrast strategy can be used is with coordinate relationships, in which knowledge is on the same level of breadth and inclusiveness. For example, if a learner understands the concept "revolutionary war" and the objective is to understand "civil war," it would help to compare (similarities) and contrast (differences) the two kinds of wars.

The ability to compare and contrast can also be viewed as a higher-order thinking skill within the analysis level of Bloom's taxonomy, in which case it is content (something to be taught) rather than method (a way to teach).

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Competency

SEE ALSO COMPETENCY MODELING AND DEVELOPMENT and PROFESSIONAL STANDARDS

A competency is defined as "a combination of skills, abilities, and knowledge needed to perform a specific task" (Jones, Voorhees & Paulson, 2002, p.1). Subject knowledge of a specific competency, authentic tasks, problem-solving skills, and demonstrations of proficiency, are those purposeful actions most undertaken for competency recognition and acceptance. Organizations have made significant inroads with employee proficiency "by providing performance-based learning opportunities built on competencies" (p.1). Following this trend, there has been tremendous growth of competency-based learning (CBL) in postsecondary education; students are assessed on their ability to demonstrate proficiency in their expertise and receive college credit towards a certificate or degree upon demonstration of mastery (Council on Education for Public Health, 2006).

Competency credit for experience in educational settings, particularly in postsecondary institutions, is directed at assessing competencies and focusing on learning outcomes through the students' demonstrated knowledge and abilities (Eastmond & Gannon-Cook, 2007, 2008). In learning environments that focus on CBL and competency-based education (CBE), curricular design, advising strategies, and teaching methods are geared towards encouraging students to integrate life experiences and also to apply what they have learned in the context of classroom learning (Brookfield, 1984; Pratt, 2002).

The major premise of competency-based learning (CBL), or (CBE), is that diplomas and credentials are awarded on the basis of demonstrated performance. CBL often defines outcomes around the standards that have been set and continually redefined by government agencies (state and local), professional associations, and accrediting bodies. These standards define levels of knowledge, skill, and abilities to which graduates must achieve and demonstrate to receive their diplomas. Competency assessments are developed by each university with qualified experts in each competency area; each university can also utilize standards set by accrediting or professional agencies. At universities with CBL criteria, programs develop along both lines.

Employers often look for CBL and CBE graduates because they possess the abilities and expertise to "hit the ground running" in the positions to which they are recruited or promoted. CBE programs tend to extend convenient quality higher education, accelerate the process of achieving a degree, and make learning more accessible and attainable for adult learners.

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Also See Additional Resources for Further Information on this Subject

Competency-Based Education (or Learning)
SEE COMPETENCY

Competency Modeling and Development
SEE ALSO COMPETENCY and PERFORMANCE IMPROVEMENT

"Competencies demonstrate the application of a generic skill to some knowledge, with a certain degree of performance" (Paquette, 2007, p.1). "Competency modeling is an attempt to describe work and jobs in a broader, more comprehensive way. Some organizations are restructuring their performance-management systems (interviewing, selecting, developing, rewarding, recognizing) around competence models" (Zemke & Zemke, 1999, p.70). In competency modeling (CM), successful applications, behaviors, and systems, are collected and stored so that corporations, colleges, and organizations can access and replicate those applications in future projects.

Core management principles integral to CM include human resource training across a number of departments, positions, and implementations, including competencies that focus on: a sense of purpose, the task needed to be learned, the time deadline, the maximum performance outcomes, and the accomplishment of strategic objectives (Sanchez & Levine, 2008). CM also includes effective assessment measurements to so that an organization may direct employee behavior toward the accomplishment of its strategic objectives. Organizations utilize CM in order to manage organizational core competencies that "drive large enterprise critical projects…but core competencies can also be more generic, with leadership working to make everyone more creative, more quality oriented, or more financially astute… the distinction in competency modeling is that (the unit of) measurement is people rather than (a) business unit" (Cooper, 2000, p.2–3). In CM assessment is conducted on several levels, addressing measurement performance of individual job competency models separately from overall innovation assessments. Competency modeling and reporting (CMAR) "includes identifying competencies, creating position models, assessing employees, reporting results, and creating input to development planning. The models then can be expanded into recruitment, hiring, orientation, employee development and succession planning processes" (Cooper, 2000, p.23).

CM can have many levels of modeling from specific job functions to combinations of management and leadership; sales and marketing; technical administration and telecommunications; quality assurance and assessment; among others (Cooper, 2000).

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Also See Additional Resources for Further Information on this Subject

Competency Use

SEE COMPETENCY and COMPETENCY MODELING AND DEVELOPMENT

Complex Learning

SEE ALSO LEARNING TYPES and PRACTICE and SCAFFOLDING

A common complaint of students is that they experience the curriculum as a disconnected set of topics and courses, with implicit relationships between them and unclear relevance to their future profession. This complaint prompted the initial interest in complex learning. The term was introduced in the 1990s to refer to forms of learning aimed at *integrative goals* (Gagné & Merrill, 1990). Learning goals that require the integration of multiple objectives are frequently encountered when instruction must reach beyond a single lesson or course, for example, when professional competencies or complex skills are taught.

Complex learning takes a holistic rather than atomistic perspective on learning and teaching processes (van Merriënboer, 2007; van Merriënboer & Kirschner, 2007). The traditional atomistic approach in education reduces complex contents and tasks into simpler elements, until a level where the distinct elements can be transferred to learners through presentation and/or practice. The elements are thus taught as ready-made pieces, which correspond to specific, single objectives. This approach works well if there are few interactions between the elements or associated objectives, but, according to the holistic perspective, it does not work well if objectives are interrelated to each other. For such integrative objectives, the whole is more than the sum of its parts. Holistic approaches basically try to deal with complexity without losing sight of the relationships between elements. They do so by teaching from simple to complex wholes. Right from the start, learners are confronted with the most important relationships between the elements of complex tasks or complex information.

A second characteristic of the atomistic approach in education is that skills, knowledge and attitudes are often taught separately. For example, knowledge is taught in lectures, skills are taught in a skills lab, and attitudes are taught in role plays. This approach makes it difficult if not impossible for learners to integrate objectives from different domains of learning. Characteristic of complex learning is that integrative objectives are assumed to be rooted in different domains of learning, including the declarative or conceptual domain, the procedural or skills domain (including perceptual and psychomotor skills), and the affective or attitudes domain. It thus refers to the simultaneous occurrence of knowledge construction, skill acquisition, and attitude formation.

Most educational theories assume that complex learning occurs in situations where learning is driven by rich, meaningful tasks, which are typically based on real life or professional tasks (Merrill, 2002). Such tasks are called learning tasks, enterprises, scenarios, projects, or problems. Well-designed learning tasks explicitly aim at integrative objectives, by forcing learners both to coordinate different aspects of task performance and to integrate knowledge, skills and attitudes. Guidance is necessary to help learners deal with the complexity of tasks, that is, to provide supports that enable them to deal with more complex content and skill demands than they could otherwise handle (van Merriënboer, Kirschner, & Kester, 2003; van Merriënboer & Sweller, 2005). Moreover, provided guidance and support should gradually decrease in a process of "scaffolding" as learners gain more expertise (Reiser, 2004).

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Composition
SEE VISUAL MESSAGE DESIGN

Computer-Assisted Learning
SEE COMPUTER-BASED TRAINING

Computer-Based Training
SEE ALSO INTEGRATED LEARNING SYSTEMS and MASTERY LEARNING and TECHNOLOGY-ENABLED LEARNING

Computer-based training, or CBT, consists of units of instruction where information presentation and learner scaffolding, interaction, feedback and assessment are primarily handled by the computer. These self-contained units of instruction, called "courseware," can be designed at any level of content granularity; that is, courseware can be designed to teach, practice and/or assess a single concept, a lesson, a unit or an entire course. Attention to mastery learning of content (Graesser, Chipman & King, 2008; Hannafin & Forshay, 2008) and self-paced engagement with the material (Hannafin & Forshay, 2008) are key characteristics. Other terms that are often used interchangeably for computer-based training include computer-based instruction (CBI), computer-assisted learning (CAL), computer-based learning (CBL), and computer-assisted instruction (CAI).

The categories of computer-based training described by Alessi and Trollip in 1985—drill and practice, tutorial, simulation, games and tests—still reflect the types of CBT available today. Within each of these categories, the process of instruction usually consists of some combination of information presentation, learner guidance, practice and testing, although not necessarily in that order. Drill and practice CBT courseware engages learners in repetitive practice of the material to be learned with learner guidance through feedback about performance. Tutorials generally focus on the processes of information presentation and learner guidance. They tend to be didactic in nature, "…presenting information and guiding the learner in initial acquisition" (Alessi & Trollip, 2001, p.11). Hyperlinks within tutorials allow students to access information within the CBT and on the Internet, but the learner usually returns to the central CBT module for questions, activity, feedback, scaffolding and, when appropriate, for testing. Simulations represent "…a model of some phenomenon or activity that users learn about through interaction…," often embodied in microworlds, virtual reality and case-based scenarios (Alessi & Trollip, 2001, p. 213). Educational games characteristically add such things as rules, competition, scoring, challenge, fantasy, control, and so on (Alessi & Trollip, 2001; Gee, 2003) to drill and practice or simulation in computer-based training (Alessi & Trollip, 2001). Authoring tools for CBT in these categories range from fill-in-the-blank lesson templates to simulation design platforms (Spector, Muraida & Marlino, 1992) for delivery online via the Web, or across networks or on unconnected computers from hard-drive or CD-ROM.

As stand-alone instruction, CBT is limited. Some CBT courseware incorporates intelligent tutoring systems to handle guidance, practice and assessment within more structured learning domains. However, computers are unable to effectively analyze, assess and provide feedback for the broad variety of open-ended student responses possible at the higher levels of learning within ill-structured disciplines and domains. As a result, stand-alone CBT tends to be more appropriate for the lower, inert and shallow levels of learning (Graesser et al., 2008). When used in conjunction with teacher-facilitated instruction, well-designed collaborative learning opportunities, blended learning formats and more constructivist instructional approaches, CBT can be an effective foundation and scaffold for meta-cognitive, analytic, evaluative and creative learning within ill-structured problem domains. CBT that is augmented with blended learning opportunities and constructivist approaches can also help to move the instruction from content-focused to learner-centered.

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Concept
SEE ANALOGY and COMPARISON AND CONTRAST and EXAMPLES AND NON-EXAMPLES and GENERALITY and LEARNING TYPES

Conceptual Elaboration Sequencing
SEE ELABORATION SEQUENCING

Concerns-Based Adoption Model
SEE CHANGE MODELS

Conditions of Change Model
SEE CHANGE MODELS

Conditions of Learning
SEE ALSO COGNITIVE LEARNING THEORY and COGNITIVE PROCESSES and INSTRUCTION

The term “conditions of learning” stems from the classic work of Robert M. Gagné (1985). There are two categories of conditions—internal and external. The internal conditions are those “mental processes which occur during an instructional situation” (Richey, Klein, & Tracey, 2011, p. 190). Gagné (1988) saw these processes from the perspective of cognitive learning theory, specifically information processing theory. They reflect the position that learning is fundamentally an internal activity. The internal conditions include tasks such as receiving stimuli into one’s sensory memory, encoding material for long-term storage, and making generalizations to facilitate transfer. (See Gagné, Briggs, & Wager, 1992, for the entire list of internal processes.) They also include all of the learner’s “previously learned capabilities” (Gagné, Briggs, & Wager, 1992, p. 9).

External conditions of learning, on the other hand, relate to instruction. They are “the manner in which instruction is arranged; the steps and activities involved in learning” (Richey, Klein, & Tracey, 2011, p. 188). External conditions include teaching strategies, student activities, and even the instructional materials used. Gagné (1985) summarizes these conditions in his nine events of instruction (gain attention, inform learner of the objective, stimulate recall of prior learning, present the content, provide learning guidance, elicit performance, provide feedback, assess performance, enhance retention and transfer). According to Gagné, these events vary depending upon the type of learning task at hand, or for differing expected outcomes of instruction (Gagné, 1988). They provide guidelines for instructional designers to follow when selecting and sequencing teaching strategies.

The internal and external conditions of learning are inextricably linked, since the external events of instruction are designed to stimulate internal learning processes. For example, the event "gain attention" facilitates the internal process of receiving stimuli in one's sensory memory, and the event "assess performance" helps the learner retrieve information from long-term memory.

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Cone of Experience

SEE ALSO VISUAL AND PICTORIAL LEARNING

Edgar Dale's (1946) Cone of Experience is a visual summary of types of sensory experiences provided by various materials (media) of the 1940s. The experiences range from direct, concrete, and sensory to indirect, abstract, and less sensory (Dale, 1946). As of the last edition of *Audio-Visual Methods of Teaching* in which the cone appeared, the types of mediated learning are from more direct at the bottom to more indirect at the top: direct purposeful experiences; contrived experiences; dramatized experiences; demonstrations; study trips; exhibits; educational television; motion pictures; recordings, radio, and still pictures; visual symbols; verbal symbols (Dale, 1969). Moving up the Cone means moving in the direction of increasing indirectness and abstractness. The location of a material or medium on the Cone is not meant to signify rigid, inflexible use of the medium. Also, the use of abstractions is not necessarily more difficult or more valuable for learners. A full graphic of Dale's (1946, 1969) Cone of Experience can be found in multiple sites on the Internet, and in many texts (e.g., Seels & Richey, 1994, p. 14).

The Cone and its variants have found uses in many instructional and training contexts, partly because it compares well with Bruner's (1966) classification system for modes of learning (from bottom to top—enactive, iconic, and symbolic) (Molenda, 2003). Also, Dwyer (1978) credits Dale and the Cone as having helped to inspire a visual education movement.

Many uses of the Cone of Experience have not conformed to Dale's original conception of it, which is why he said not to "mistake the cone device for an exact rank-order of learning processes" (Dale, 1969, p. 128). Further, it is a mistake to use the Cone to somehow advance one's favorite medium-message, and Dale advocated use of whatever media and methods were appropriate to specific tasks and learners (Molenda, 2003). Other difficulties attend the Cone. For example, to the extent the Cone indicates a theory, Subramony (2003) says it is a nebulous theory.

Since the cone first appeared, various adaptations and other media selection devices (or "theories," "models," "taxonomies," "sets of principles," "graphic representations," "frameworks,"…) have been proposed and used (e.g., Wager, 1975; Levy, 1977; Reiser, 1982; Massey & Montoya-Weiss, 2006; Zaied, 2007; Cisco Systems, Inc., 2008; Tamim, Bernard, Borokhovski, & Abrami, 2011). Issues of media characteristics have even stirred up some interesting debate (Clark, 1983; Kozma, 1994), especially when Clark (1994) went so far as to say, "Media will never influence learning" (p. 21).

Educators may have wanted to use the Cone to suggest a precise process for using media, but that was not what Dale intended. Current efforts to design the use of media and technologies consider our knowledge that instruction and learning are the following: complex; reliant on human cognition, motivation, and biology; situated in practical needs, possibilities, and constraints of context (such as teacher qualities, politics, economics, societal influences, or culture). "The reality is that the most effective designs for learning adapt to and include a variety of media, combinations of modalities, levels of interactivity, learner characteristics, and pedagogy based on a complex set of circumstances" (Cisco Systems, Inc., 2008, p. 12).

More particularly, education professionals are likely to consider instructional media and technologies in relation to factors such as adaptation, affordances, support structures, integration, collaborative learning, teachers' influence and professional development, authenticity, meaningfulness, media literacy. (Clark & Estes, 1999; Dick, Carey & Carey, 2011; Howland, Jonassen & Marra, 2012; Inan & Lowther, 2010; Morrison, Ross, Kalman, & Kemp, 2011; Smaldino, Lowther, & Russell, 2011).

The question implied by Dale's (1946) Cone of Experience persists, perhaps because it is so reasonable. How do people choose media and technologies that are more likely to foster appropriate learning? Within his time and circumstances, Edgar Dale was not doing much more with the Cone of Experience than asking teachers to consider this kind of question and its implications. To this modest extent, at least, he was successful.

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Confirmative Evaluation
SEE EVALUATION

Consumer-Generated Content
SEE USER-GENERATED CONTENT

Constructivism
SEE ALSO COMMUNITY OF PRACTICE and CONSTRUCTIVIST APPROACH and LEARNER-CENTERED INSTRUCTION and SITUATED COGNITION

Constructivism draws primarily on the work of developmental psychologists, Jean Piaget and Lev Vygotsky, and asserts that humans learn by constructing knowledge; that is, by connecting new information to previously learned knowledge. Both viewed learning as inherently linked to interaction with one's environment; however, Piaget (1954) viewed development as the necessary precursor to learning, while Vygotsky (1962, 1978) viewed learning as preceding development. With its focus on learning leading to development, Vygotsky's perspective came to be seen as more helpful for educational programing.

In constructivism, learning takes place on two planes: it first occurs as individuals interact with one another and later becomes internalized as the individual appropriates that learning. Furthermore, for the novice, learning best takes place when it occurs through scaffolded interaction with a more knowledgeable other in the novice's ZPD; that is, instruction should push the novice just beyond what he or she can accomplish without assistance (Vygotsky, 1978). The social nature of learning, as theorized within constructivism, notes the active use of culturally defined tools. Ways of using these tools are passed from one generation to the next. Thus, learning continues to be social in nature, even when others are not physically present, as an individual interacts with culturally constructed tools. Wersch (1985) and Bruner (1990) stipulate that learning must also be goal-driven in order to be effective. Lave and Wenger (1991) and Wells (2005) build on these ideas to demonstrate that learning best takes place in communities of collaborative inquiry.

Flowing from a constructivist perspective is the notion of situated cognition, which theorizes human thought as always constructed in a situated context. In other words, it is formed in a specific time, place and social setting (Robinson, Molenda, and Rezabek, 2008). Drawing on the importance of context in learning, instruction informed by situated cognition seeks to embed learning in realistic and relevant environments and attempts to provide opportunity for negotiation of meaning between novice and expert (Driscoll, 2005).

Constructivism is viewed as the contemporary alternative to behaviorist conceptions of learning and instruction. Applied to educational technology in its early days, behaviorism led to CAI in which practice was the primary goal and reinforcement of positive responses the main instructional strategy (Hartley, 2010). However, constructivism has been the foundational perspective guiding educational technology for the past two decades (Hartley, 2010; Molenda, 2008). Situated cognition, problem-based and inquiry-based learning strategies, prevalent in current technology enhanced learning environments, rely heavily on the constructivist notions of collaborative learning and authentic learning experiences for engaged learning.

While seen to provide a well-grounded description of learning, some argue the constructivist principle of "minimal guidance" inherent to problem and inquiry-based learning may be ineffective for learners at the novice or intermediate stages of learning in a program or discipline. Such learners may require programs with more explicit guidance (Kirshner, Sweller and Clark, 2006, Cronje, 2006). Furthermore, the directive that learning be seen as cognitive apprenticeship where "scaffolding, modeling, mentoring and coaching" are always present (Dennen, 2004, p. 813) may preclude instruction through a variety of modes.

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Constructivist Approach

SEE ALSO AUTHENTIC ACTIVITY and CONSTRUCTIVISM and INSTRUCTIONAL DESIGN MODELS

Constructivism is a philosophical epistemology that is centered on a person's active participation in the construction of meaningful reality. As an epistemologist, Piaget wrote about the acquisition of knowledge as the learner interacts with the world around him. He used the term "constructivist epistemology" in his 1967 book *Logic and Scientific Knowledge*. In this book, Piaget discusses the importance of interacting with the world through the senses. Our capability to experience our surroundings is an important factor in how we create meaning of the world.

An individual creates meaning from his or her personal interaction with the environment. The interaction may follow along a continuum from awareness, to exploration, to construction of meaning. Oliver (2011) advocates that this continuum could form the basis of a teaching approach. This report discusses the teaching and learning of the scientific concept of evolution. The teacher provides an environment in which certain practical steps are followed. The steps start with an exploration of the topic and lead into a challenge of the tenants of the concept under study. They continue to one of exploration and reflection as the student continues to interact with the subject.

Barron (2007) discusses a series of events as a student of music explores elements of jazz until she constructs her own meaning of the music as it relates to her world. The student listens to the music and makes connections to other musical styles. She creates a meaningful representation of the music as it affects her. Students in constructivist classrooms create an individual meaning of concepts they are studying. Correiro, Griffin, and Hart (2008) discuss the responsibility a student assumes in creating a meaningful representation of the learning.

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Content Management Systems
SEE MANAGEMENT SYSTEMS

Context
SEE ALSO CULTURE-NEUTRAL DESIGN and CULTURE-SPECIFIC DESIGN and MOTIVATION and PERFORMANCE IMPROVEMENT and TRANSFER

Context has been generally defined as “the whole situation, background, or environment surrounding a particular event” (Webster’s New World Dictionary, 1988, p. 301). It involves a complex set of factors that are not simply “the additive influence of discrete entities, but rather the simultaneous interaction of a number of mutually influential aspects” (Tessmer & Richey, 1997, p. 87). Some have argued against viewing context as “something into which one is put,” but rather see it as “an order of behavior of which one is part” (McDermott, as cited by Lave, 1996, p. 19). Context in this perspective is viewed as a situated activity that also includes historical practices (Lave, 1996). Context plays an important role in both learning (i.e., the acquisition of knowledge and skills) and performance (i.e., the application of knowledge and skills); it can serve as either an impediment or a facilitator of both.

There are three types of context that impact teaching and learning—the orienting context, the instructional context, and the transfer context (Tessmer & Richey, 1997). The orienting context includes factors that impact a student’s motivation and preparation for the learning task. This can encompass many previous events over a long period of time. The instructional context consists of both physical and psychosocial factors evident during the time instruction takes place. These factors are manifested not only during the delivery of instruction, but may also include learning activities in preparation for instruction or practice activities after instruction. The transfer context is the environment in which the material learned will be applied. For many, this is the most important context. Like the orienting context, it too includes a wide variety of motivational factors such as incentives, resources, peer and supervisor support.

The role of context and its place in instructional design has grown over time and is now a standard phase in many ID models. For example, the model of Morrison, Ross, Kalman and Kemp (2011) includes contextual analysis as a major part of the consideration of learner characteristics. Dick, Carey and Carey (2009) also have a design phase devoted to analyzing learners and contexts. Both separate context analysis from the analysis of content. In the performance improvement approach contextual factors play a dominant role in performance analysis and cause analysis (Van Tiem, Moseley & Dessinger, 2004).

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Contextual Analysis
SEE ANALYSIS

Contrast
SEE VISUAL MESSAGE DESIGN

Copyright
SEE INTELLECTUAL PROPERTY

Course Management System
SEE MANAGEMENT SYSTEMS

Creative Commons License
SEE INTELLECTUAL PROPERTY

Criterion-Referenced Measurement
SEE ALSO ASSESSMENT and INSTRUCTIONAL OBJECTIVES

Criterion-referenced measurement was a term originally coined by Glaser (1963), and is essentially used to determine the status of a performer with regards to some criterion, such as a performance standard. Conversely, norm-referenced measurement, also coined by Glaser, is used to determine the status of a performer, with regards to others on the same measure (Popham & Husek, 1971). Thus, criterion-referenced measurement helps us determine what the performer can perform, independent of how his or her performance compares to that of others. However, a criterion-referenced test could still potentially be used to make comparisons among performers.

Glaser (1963) noted the importance of understanding two key uses of criterion-referenced measures. While norm-referenced measurement can be used only to make decisions about individuals (for example, which candidate performed better), criterion-referenced measurement provides information about an individual, as well as about the conditions or instructional treatment. For example, administering a criterion-referenced measure after a learning or performance intervention can tell us not only about the individual's level of performance, but it can also be used to determine the effectiveness of the intervention.

The move from norm-referenced to criterion-referenced testing was considered a dramatic paradigm shift. It was, in part, a response to the outgrowth of instructional programs that were set up and executed based on clear-cut learning objectives (Van der Linden, 1982).

One limitation of criterion-referenced measurement is that it does not tell all that there is to know about what the performer does well, and what he or she does poorly (Ebel, 1970). However, the same could be said for any type of measurement, including norm-referenced. A comprehensive and pragmatic performance measurement effort should shed light not only on the outcome-based criterion, but should also set out to measure relevant factors that allow for specific and corrective feedback to support performance improvement (Guerra-López, 2007).

Today, the emphasis on performance objectives is ubiquitous and while it can be argued that many so-called objectives are not accomplishment or outcome driven, but rather activity-driven, they are still used as the basis for measurement and evaluation. Careful consideration should be given to the criteria that are or will be used to determine successful accomplishment of a performance objective.

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Cueing

SEE PROMPTING

Cue Summation Theory

SEE MULTICHANNEL INSTRUCTION

Cultural Capital

SEE CULTURAL THEORY

Cultural Historical Activity Theory

Cultural Historical Activity Theory (CHAT) has become a popular theoretical framework within instructional/educational technology. It has been referred to in other forms such as socio-cultural theory, socio-historical theory, and activity theory. When referring to this theoretical framework researchers will notice that there seem to be slightly different theoretical developments between CHAT and socio-historical theory. Researchers need to remember that communications between Western and Russian scholars were very limited while the Soviet Union was in place and as a result there are some fractured historical developments in theories related to CHAT. Nevertheless, there is growing interest in this framework among mainstream educational researchers and instructional/educational technologists as represented in such works as Roth and Lee (2007).

When authors refer to CHAT they often go back to works of Russian scholars in the 1920s and 1930s such as Vygotsky (1978) and Leontiev (1981) as early pioneers who enabled researchers to move away from the Cartesian dualistic treatment of the organism and the environment. Vygotsky introduced mediated action as a process for individuals to make meaning of their world and develop consciousness through semiotic interactions with artifacts, tools, and other human beings in the environment (Yamagata-Lynch, 2010). This approach to understanding human development moved away from the stimulus and response model that dominated Russian psychology in the 1920s. Mediated action involves the subject, tool/mediating artifact, and object as an inseparable unit of analysis for understanding human activity. There is considerable discussion, due to translation issues, about the "object" (for example, see Kaptelinin, 2005; Nardi, 2005; and Hyysalo, 2005), but for all intents and purposes it should be referred to as the reasons individuals or groups of individuals choose to participate in an activity (Yamagata-Lynch, 2007).

Among instructional/educational technology researchers and practitioners activity systems analysis has become a popular methodological framework. Activity systems analysis is one approach within CHAT for examining complex human activity. It gained widespread recognition within the Western educational research community after the publication of Cole and Engeström (1993) and Engeström (1993). It should be noted that some works refer to CHAT and activity systems analysis interchangeably, but they are not the one and the same because CHAT is the theoretical framework and activity systems analysis is one analytical framework within CHAT. Activity systems are represented as a triangular model that is based on mediated action, but includes socio-cultural aspects of human activity referred to in the model as rules, community, and division of labor (Engeström, 1987). Yamagata-Lynch (2010) has articulated how scholars new to CHAT and activity systems analysis can engage in analysis of complex human learning activities. She proposed activity systems analysis as a supplementary analytical framework for qualitative researchers to use after the coding process and writing the thick description narrative. According to Yamagata-Lynch, the potential benefits from this additional analysis include: (a) introducing a manageable unit of analysis, (b) finding systemic implications across activities, (c) addressing contradictions and tensions, and (d) introducing an alternative form of communication of research results.

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Also See Additional Resources for Further Information on this Subject

Culture-Neutral Design

SEE ALSO CONTEXT

The term culture-neutral, also referred to as culturally neutral, appears in instructional design research in a variety of contexts; however, all are tied to culture. The meanings behind culture-neutral design demonstrate a focus on factors to consider in the design process. In particular, culture-neutral examples explore design as it relates to project and product development, content (i.e., instructional materials), tools (i.e., technology), people (i.e., human performance), and practice (i.e., educational research). Collectively, there is no standard definition for the term "culture-neutral."

In the examples of project and product development, Young (2008) states that "if the goal of the project is to internationalize, then the design specifications are generic and culture-neutral. Generic features can be generalized across cultures but they are still culture based" (p. 9). Thomas, Mitchell & Joseph (2002) argue that:

> …although it may seem obvious that instructional designers intend to make culturally sensitive products, this is not always the case. Too often the intention is not to make a product that is culturally sensitive or culturally appropriate but culturally neutral. This is often done in an attempt to avoid cultural bias but also occurs as an unhappy consequence of cultural neglect or arrogance. If culture is at the heart of our thoughts and worldview, it is an inescapable element in all that we do, say, feel, wish and design (p. 42).

Bentley, Tinney & Chia (2005) suggest that "when designers know they will have both native and nonnative speakers responding to the instructional discourse style, as much as possible they should create materials that are culturally neutral" (p. 125). This means using "a simple sentence structure and avoiding slang, colloquialisms, local humor, and local insider examples whenever possible … and consider that in some ways they are always designing for a global audience" (Bentley, et. al., 2005, p. 125).

Other examples of culture-neutral design point to tools, people and practice. Gunawardena & LaPointe (2008) ask, "Why is it necessary to understand the social and cultural factors that influence international distance education? Reasons that come to mind are…recognition that technology connects us but is not culture-neutral" (p. 52). Lee (2011) conducted research on international students' perceptions of the teacher's role in an online multicultural learning environment in Korea. On the administered survey, one of the pedagogical factors examined was whether teachers could "be culturally neutral regarding content" (p. 922). Parrish & Linder-VanBerschot, (2010) "argue that research-based educational practices *transcend* culture or are culture-neutral and that it is simply good practice to use what research tells us works, regardless of cultural differences" (p. 14).

Future use of the term "culture-neutral" should be labeled as such to accurately represent its specificity. Terms such as multiculturalism and cultural pluralism may not provide as precise representations.

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Also See Additional Resources for Further Information on this Subject

Culture-Specific Design
SEE ALSO CONEXT

The term "culture-specific" has been used to describe learners, learning, learning technologies, design applications, computer technology, and models of culture. However, collectively, there is no standard definition for the term "culture-specific."

The meanings behind culture-specific are as diverse as culture itself. Jonanssen, Tessmer & Hannum (1999) state that "tools can be anything used in the transformation process (physical, like hammers or computers or mental, like models, theories or heuristics). The use of culture-specific tools shapes the way people act and think" (p. 161). Palaiologou (2009) proposes that "pedagogical strategies and learning models with an intercultural approach might include: (a) culture-specific and culture-general knowledge" (p. 282). In addition, Kinuthia (2007) asserts that:

> Many aspects of language and communication such as humor and idioms are culturally relative or specific. This means that interface and content design should take into consideration the content layout, menus, images, color, symbols, and text layout because these elements influence the intended messages (p. 66).

Chen (2007) examined biases in computer software pointing out a "cultural preferences for such things as analytic and linear thinking, the way information is organized, and culture-specific logic and rules" (p. 1114). Culture-specific has also been used to describe learning technologies created for an ethnically diverse target audience or group (Elen, et al., 2010; Frederick, Donnor, & Hatley, 2009; Subramony, 2006).

Culture-specific design is used to explain models of culture or frameworks that guide the design of products or environments for target audiences. For example, McLoughlin's (1999) model of online learning incorporates "culture specific values, styles of learning and cognitive preferences, and tasks that were designed to go beyond surface level comprehension to achieve deep learning." (p. 231). Young's (2009) model of culture states that:

> All designs are based in culture; however, some are culture neutral and others culture-specific. This means that all designs are culture-based, but the degree to which one is more neutral and the other more specific is based on the goals of the project and the final product (p. 29).

The term "culture-specific" is typically more accurate and precise than the terms "culturally relevant" and "culturally responsive."

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Also See Additional Resources for Further Information on this Subject

Curriculum

Curriculum, in the briefest meaning of the term, is a course of studies, or what is to be taught. This immediately becomes problematic within an epistemological and philosophic sense as soon as one asks "Who decides?" The answer ranges from "the teacher" to "a curriculum committee" to "a government authority." The classic historic statement of the issue was Herbert Spenser's (1861) "What knowledge is of most worth?" (p. 1). William Shubert (1986) expanded upon this in his comprehensive and synoptic curriculum text which began "What knowledge is most worthwhile? Why is it worthwhile? How is it acquired or created? These are three of the most basic curriculum questions." (p. 1). Robin Barrow (2006) provided a useful twenty-first century restatement of the age–old curriculum focus:

> The task before us now is to attempt to outline what kinds of knowledge we ought as educators, to be concerned to pass on to students or, more generally, the kinds of things we ought to seek to promote when teaching/learning takes place (p. 38).

Curriculum development often follows a systematic technological model and in that sense parallels *instructional development* or *instructional design*.

Some curriculum theorists see technology as a serious force that will change and disrupt everything: "Since the advent of the public Internet in May 1995, knowledge can no longer adequately serve as an organizer for curriculum…there is neither scope or sequence to the new information age" (Wiles & Bondi, 2007, p. 298). The role of technology in curriculum development is as yet an unwritten chapter in twenty-first century pedagogy.

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D

Design and Development Research

Design and development research is a type of inquiry unique to the instructional design and technology field that is dedicated to the creation of new knowledge and the validation of existing practice. It has been defined as "the systematic study of design, development and evaluation processes with the aim of establishing an empirical basis for the creation of instructional and noninstructional products and tools and new or enhanced models that govern their development" (Richey & Klein, 2007, p. 1). It has also been called developmental research (Richey, Klein, & Nelson, 2004; Richey & Nelson, 1996; Seels & Richey, 1994). There are other terms related (and often confused) with this type of research. These are design-based research (Wang & Hannafin, 2005), formative research (Reigeluth & Frick, 1999; van den Akker, 1999), and systems-based evaluation (Driscoll, 1984). However, these types of research tend to focus on the development of particular instructional materials and typically do not draw conclusions about the design and development processes.

Design and development research encompasses two main categories of research projects: (1) research on products and tools and (2) research on design and development models (Richey & Klein, 2007; 2013). Product research is typically conducted during the design and development process. Often this is a comprehensive study of the entire process. See, for example, Cifuentes, Sharp, Bulu, Benz, and Stough's 2010 study of the design, development and evaluation of an informational and instructional Web site. However, the research may involve only the examination of particular phase of the design and development process. Some research is directed not towards instructional products, but toward the development of tools used in either instruction or the design processes. For example, Hung, Smith, Harris, and Lockard's (2010) research focuses on the development of a performance support system for classroom behavior management.

The second type of design and development research pertains to studies of the development, validation, and use of design and development models. Model development research may result in new, enhanced, or updated models to guide the instructional design (ID) process or a part of the process, such as Jones and Richey's (2000) study which resulted in a rapid prototyping ID model. Model validation research, on the other hand, demonstrates the effectiveness of a model's use in a real-world setting (i.e., external validation) or provides support for the various components of a model (i.e., internal validation) (Richey, 2005). Finally, model use research focuses on the conditions that impact model use; these show the interplay between varying design and development contexts and model effectiveness. Tracey's (2009) research combines these two types by providing data to validate a multiple intelligence ID model as well as to test the usability of the model by designers.

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Design-Based Research

Design-based research (DBR) is a research and development methodology used to develop, apply and test design principles that are instantiated as meaningful interventions in operating learning contexts. The term was first applied in educational contexts by Collins (1992) and Brown (1992) and is used interchangeably with the term "educational design-research" and has come to replace the term "development research" (van den Akker, 1999).

Although there are a number of related definitions, the one given by Wang and Hannafin (2005) is widely quoted. DBR is "a systematic but flexible methodology aimed to improve educational practices through iterative analysis, design, development, and implementation, based on collaboration among researchers and practitioners in real-world settings, and leading to contextually sensitive design principles and theories" (p. 6).

DBR is characterized by:

- Pragmatic epistemology focusing on important problems from the perspectives of both educators and researchers.
- Use of multiple data collection methods.
- Testing of the intervention in operating classrooms, online or other "naturalistic contexts" (Barab & Squire, 2004).
- Active collaboration between researcher(s) and educator(s) in the design, construction, application and assessment of the intervention.
- Refinement and improvement of the intervention through multiple iterations.
- Development of theoretical insights or design principles that extend the results of the research beyond a local context.

DBR has been increasing in use over the past decade, especially in the USA, and has been used at all levels of formal education in all subjects (Anderson & Shattuck, 2012). Although DBR can be used to develop and test any type of pedagogical intervention, it has been most strongly identified with constructivist designs that acknowledge the complex role of the communities in which learning takes place. Many different kinds of interventions have been designed and tested using DBR methodology with the largest single type of intervention being various applications of educational technologies and associated instructional designs.

The requirement for multiple iterations has created challenges for graduate students and those with short term research funding. Most of the well-known DBR projects have involved larger research teams and multiyear funding though there are examples and suggestions for smaller scale DBR projects (Herrington, McKenney, Reeves & Oliver, 2007).

DBR resonates with the pragmatic philosophy of John Dewey and William James with a focus on the development of important interventions that can be implemented in working educational contexts. DBR experiments gather a variety of empirical data and are informed by the qualitative insights of practitioners, learners and the researchers themselves. DBR researchers pay attention to and document the real and opportunity costs and time associated with the intervention and use these in comparison to the documented changes in practice or outcomes.

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Also See Additional Resources for Further Information on this Subject

Designer Decision-Making Research
SEE ALSO EXPERTISE

Designer-decision making research has been defined as "investigations of designer activities including designer problem-solving, thinking, and use of models;" (Richey & Klein, 2007, p. 156). In these studies the designer is the focus of the research, not the products of the design and development projects or student learning processes. Designer characteristics are often objects of these studies, especially the differences between novice and expert designers.

Designer-decision making research typically relies on qualitative methodologies. Rowland's (1992) classic study of this type used "think-aloud" techniques to compare how expert and novice designers completed an assigned task. The thoughts and decisions made were analyzed to determine exactly how the instructional design (ID) process works. Perez and Emery's (1995) research similarly identified the differences of the cognitive processing and problem-solving paths of novice and expert designers.

Another more recent example of this type of research is that of Visscher-Voerman and Gustafson (2004). They conducted in-depth interviews and a review of project documents to explore the intricacies of the ID process as it actually occurs. Designers were specifically selected to represent different work environments. This study produced detailed descriptions of designer activities, the rationales for the tactics taken, and the underlying paradigms that guided their work.

Research of this genre has also been used to study particular design tasks of selected groups. Recently there has been an increased emphasis on the use of technology. For example, Hart (2008) studied the tactics classroom teachers use to integrate technology into their lessons.

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Development

Over the years, the meaning of the term “development” has generated considerable discussion. This debate has focused typically upon the distinctions between instructional design and instructional development. Some view design as the planning phase in which specifications are constructed, and development as the production phase in which the design specifications are translated into physical form (Seels & Richey, 1994; Richey, Klein & Tracey, 2011). Historically others have broadly defined each of the terms so that they have similar meanings. For example, Briggs (1977) defined instructional design as “the entire process of analysis of learning needs and goals and the development of a delivery system to meet the needs; includes development of instructional materials and activities; and tryout and revision of all instruction and learner assessment activities” (p. xx). In this interpretation, design is the more generic term, encompasssing both planning and production. In contrast Smaldino, Russell, Heinich and Molenda (2005) define instructional development as “the process of analyzing needs, determining what content must be mastered, establishing educational goals, designing materials to reach the objectives, and trying out and revising the program in terms of learner achievement” (p.386). However, many consider this to be a definition of the instructional systems design process, and in their most recent edition of their book, this broad definition of “development” is omitted. It may be that the controversies surrounding this term have diminished. Currently, scholars and practitioners often speak simply of “development” rather than “instructional development” in keeping with expanded definitions of the field that encompass notions of performance improvement and noninstructional interventions (Reiser, 2007).

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Developmental Evaluation
SEE EVALUATION MODELS

Developmental Research
SEE DESIGN AND DEVELOPMENT RESEARCH

Differentiated Instruction
SEE ALSO LEARNER-CENTERED INSTRUCTION

Lifting (2010) states, "Differentiated Instruction (DI) is an ongoing practice: teachers intentionally and systematically discover and plan lessons around the strengths, needs, prior knowledge, and attitudes of their students" (p.1). While this seems a natural approach, it was not always the standard philosophy. In 1995, Carol Ann Tomlinson analyzed the different types of learners in a middle school class. At that time, the phrase "all children can learn" was used in many school systems. Unfortunately, many teachers thought that if a strategy worked well for one student, then that same strategy would work well for other students. Tomlinson (1995) posits that different learners need different structures to learn. The content may remain the same, but each student needs supports that are designed for the needs of that individual child.

Manning, Stanford, and Reeves, (2010) examine classes of advanced learners and others. They suggest that not only could advanced learners benefit from DI, but that all learners could benefit as well. De Lay (2010) continues the discussion stating that differentiated instruction is a necessary strategy for teachers to use in their classrooms.

David Carbonara

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Diffusion of Innovation
SEE INNOVATION

Digital Cartography
SEE DIGITAL MAPPING

Digital Divide

Generally, the digital divide refers to the gap between those who can access and benefit from digital technology and the Internet and those who cannot. The term "digital divide" is associated with inequalities between groups or populations in knowledge of, access to, and use of information, communication and media technologies. Early considerations of the digital divide in education tended to focus on access to digital technologies such as mainframe and personal computers. Given the proliferation of lower cost desktop and laptop computers, digital cameras, tablets and smartphones, the emphasis on addressing the digital divide in K-12 schools has shifted to understanding who has access to broadband and wireless Internet (Fox, Waters, Fletcher & Levin, 2012).

In-depth research on the digital divide moves well beyond simply considering technological aspects of access, such as means of connectivity, infrastructure and level of connectivity. It now also considers the social, ethical, economic, geographic, political, cultural and global aspects of those who derive the greatest benefits from access to digital technology and the Internet, and those who do not. For example, an analysis of the digital divide might focus on the access and benefit gaps between populations in urban and rural settings, developed and developing nations, affluent and poverty situations, open and closed societies and governments. Individual and group variables, such as age, gender, skills, education, language, culture, and income also interest digital divide researchers and analysts. While access to various types of digital technology, such as mobile phones (Karnowski, von Paper & Wirth, 2008), is part of understanding the digital divide between those who have access and those who do not, the larger and more complex issue of interest is who does and does not derive benefits from access to digital technology and the Internet (Norris, 2003; Warshauer, 2003; Wei, Teo, Chan & Tan, 2011).

Warschauer (2003) evaluated how differing levels of access to digital technology can contribute to economic and social stratification or inclusion. The central premise of Warschauer's (2003) digital divide research is that the ability to access, adapt and create knowledge using digital technologies is critical to social inclusion. This shifts discussion of addressing the gap away from distributing devices or strengthening the technological infrastructure towards the social development and support of communities in order to make best use of technologies to engage in meaningful social practices.

Recent use of social media by political protesters to organize and coordinate political activity raises questions of who has access to and can benefit from digital technologies and networks, and who cannot. Almost a decade ago, Norris (2003) studied the political role of the Internet in countries in the Organisation for Economic Cooperation and Development, and found that usage patterns reflect and reinforce rather than transform the structural features of a country's political systems. So, while the Internet can offer a mobilizing structure to those who have the means to connect and can leverage open connectivity, there is still a significant proportion of the world's population who cannot.

Recent research demonstrates how the concept of digital divide continues to evolve. Wei, Teo, Chan and Tan (2011) draw upon social cognitive theory and computer self-efficacy literature to model how the first-level digital access divide affects the second-level digital capability divide and the third-level digital outcomes divide among students in Singapore. This brief overview of issues and topics relevant to the digital divide provides insight into the complexity and multifaceted nature of research on the digital divide concept.

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Also See Additional Resources for Further Information on this Subject

Digital Game-Based Learning

SEE ALSO AVATAR and GAME DESIGN and SIMULATION and VIRTUAL WORLDS

Digital game-based learning is generally understood as learning that is facilitated or supported by a digital game or games (deFrietas, 2006; Van Eck, 2006). The literature has described games and digital games in a fairly consistent way. In their book *Rules of Play*, Salen and Zimmerman (2003) defined games as systems "in which players engage in an artificial conflict, defined by rules, that results in a quantifiable outcome." Gredler (2004) details the use of games for learning at least as far back as the use of war games in the 1600s and describes games as "competitive exercises in which the objective is to win and players must apply subject matter or other relevant knowledge in an effort to advance in the exercise and win"

(p. 571). Suave, Renaud, Kaufman, and Marquis (2007) identify six essential attributes of educational games: a player or players, conflict, rules, a predetermined goal, a game's artificial nature, and a game's pedagogical nature.

When researchers and practitioners examine digital game-based learning, there are several ways in which games may be categorized, including according to their purpose and specific characteristics of the games in question. Games developed initially for the commercial entertainment market, for example, are commonly called "commercial-off-the-shelf games" (Charsky & Mims, 2006; Van Eck, 2006), and are often examined in terms of how they may be repurposed for teaching and learning. Games designed and developed specifically for learning are often referred to as "serious games" (Abt, 1970; Aldrich, 2009; deFreitas, 2006). Games can also be categorized, much like literature and film, by genre. Apperly (2006) describes four key game genres:

1. *Simulation*: The features of simulation form the central experience, but include elements of games (such as those described by Suave et al., 2007). This genre includes sports games, flight simulation-games, and driving games.
2. *Strategy Games*: (including Real-Time and Turn-Based Strategy): These often feature a macro or "gods-eye" view of an environment in which players organize and evaluate information in and out of the game to make decisions regarding manipulated game variables.
3. *Action Games*: (including first-person shooters and third-person games): These games connect the player to the game world through the eyes or body of an avatar; the player takes action in and on the world through that avatar.
4. *Role Playing Games*: In these games the player takes a specific role, often adopting a particular avatar, then acts with and through that role to navigate, and often determine, the narrative of the game. This genre includes some very popular variants including MORPG (multiplayer online role playing games) and MMORPGs (massively multiplayer online role playing games). An example of these includes the popular World of Warcraft (Steinkuehler & Duncan, 2008).

Some researchers and practitioners creating learning games have begun to suggest effective strategies and best practices in developing games for facilitating learning based on adaptations of traditional instructional design processes (Shelton & Scoresby, 2011). Others focus on the learning skills embedded in games and using games to facilitate learning and inform serious game design; they also analyze them to improve instructional practices in general (Gee, 2010; Hammer & Black, 2009; Sardon & Devlin-Scherer, 2010; Barab, Thomas, Dodge, Carteaux, & Tuzun, 2005). Finally, many researchers examine situations in which learners create digital games as a part of some broader learning experience (Hayes & Games, 2008; Barbour, Reiber, Thomas, & Rauscher, 2009; Salen 2007).

In response to the need for more rigorous analysis of the benefits and effects of digital games on learning (Clark, 2007; Van Eck, 2006), some researchers now assess these effects (Chuang & Chen, 2009; Ke, 2008), as well as explore the role of games in society, design, and educational practice in general (Squire, 2007). Others investigate strategies for facilitating game use in traditional learning environments (Gunter, Kenny & Vick, 2008; Kebritchi, 2010), and their ability to facilitate shared learning, community building, and communication (Steinkuehler, 2008).

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Digital Games
SEE DIGITAL GAME-BASED LEARNING

Digital Literacy
SEE LITERACY

Digital Mapping

Digital mapping (also called digital cartography) is a procedure which includes the compilation and formatting of information into a virtual image. This technology is used primarily to create detailed maps of a specific area, and may include details of major roads and other points of interest. The technology allows the calculation of distances from once place to another. In addition to physical phenomena, digital cartography can be representative of social, economic and cultural data that are necessarily connected to geographical aspects. Recent technological developments in computer hardware and software, coupled with high speed Internet access and the advent of Web 2.0, have changed digital mapping more rapidly than any other technological developments since the dawn of thematic cartography (MacEachren, 1996; Goodchild, 2007). These technological innovations have had a great impact on the purpose of cartography, shifting it from merely being a tool of spatial communication to a tool of spatial exploration.

The development of new 3D IT techniques, and 3D animation, allows for the exploration of the characteristics of a map, and also to "visually enter" the virtual center (Adami & Guerra, 2006). Virtual reality techniques now make interaction with maps possible.

Geographic or Spatial Information System (GIS, or SIS) is a special type of ICT that integrates hardware, software, and data for and applications capturing, managing, analyzing, and displaying all forms of geographically referenced information for comprehending geography and making intelligent decisions. Advances in scientific visualization are changing the role of maps and other graphics as tools of scientific investigation (Latu, 2009).

Digital mapping can be found in a variety of computer applications such as Google and Global Positioning Systems, or the GPS satellite network used in automotive navigation systems.

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Digital Natives and Immigrants

In 2001, Marc Prensky popularized the terms "digital natives" and "digital immigrants" in a two-part article published in *On The Horizon* (Prensky, 2001a; Prensky, 2001b). Prensky was the first to combine the terms "digital natives" and "digital immigrants" in a call to action for changed contexts and changed teaching practices in schools. Prensky (2001a, 2001b) uses the term "digital natives" to describe individuals who have grown up with digital technology, namely computers, video games, digital music players, video cameras, cell phones, e-mail, instant messaging and the Internet, as a ubiquitous part of their environment. Prensky suggests that digital natives think and process information differently than earlier generations, and that digital natives are native speakers of the digital language, because of their ubiquitous exposure to and interaction with digital technologies for their entire lives.

Prensky (2001a, 2001b) uses the term "digital immigrants" to describe individuals who were not born into the digital world, but during some point in their lives they have adopted digital technology. Prensky suggests that digital immigrants retain an accent, a marker that they have adapted to the digital world rather than being born into it; the accent indicates that digital immigrants have been socialized differently than digital natives. Prensky (2001a, 2001b) describes how digital immigrants might print and distribute an e-mail or Web site, or talk about dialing a phone or listening to a record, or refer mainly to broadcast media.

In a later work, Prensky (2012) acknowledges Douglas Rushkoff's (1996) idea of native speakers of technology and his term "screenagers," which describes children born into a culture mediated by computers and television and indicates children's interaction patterns than differ from earlier generations. Jacobsen and Lock (2004) argued that unlike their teachers, screenagers engage fluidly in online, interactive digital environments and virtual spaces, participate in rapid-fire, nonlinear, chaotic, multisensory digital media worlds, and invent uses for computers and networks that adults often do not anticipate, do not appreciate and frequently misunderstand. Prensky (2012) also acknowledges Barlow's (1996) declaration of the independence of cyberspace, and his description of children as natives in a world where adults will always be immigrants.

Since 2001, the terms "digital natives" and "digital immigrants" have been embraced and built upon by others (Tapscott, 2009), and have also been subjected to a critique of their validity and usefulness (e.g., Bullen, Morgan & Qayyum, 2011). Prensky (2009) captured a shift from the emphasis on digital immigrants and digital natives to the concept of digital wisdom in a paper in *Innovate.* He also outlined the best strategies to teach and support deep and engaging learning by digital natives in his book, *Teaching Digital Natives: Partnering for Real Learning* (Prensky, 2010).

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Digital Storytelling

Digital storytelling is an educational practice that combines a tale with digital media. Sadik (2008) reports that students are asked to use real-world situations as the basis of the digital story. Students often craft the story around some aspect of their own lives (Heo, 2009). This strategy provides an authentic background for the students (Maina, 2004).

Stories are an important vehicle for transferring knowledge from one person to another. Thornburg (1999) discusses the evolution of the sharing of stories over time. He imagines that stories were once transmitted from one person to another as they gathered water from the local watering hole. Amphitheaters in ancient Greece and Rome provided formal venues for the stories. Guttenberg provided the movable type to create printed versions of stories that were widely distributed. We now have e-mail, blogs, wikis, and other Web 2.0 tools to circulate the stories.

The development of end-user tools to add digital content to textual stories enhances the delivery of the stories. Pictures taken with a digital camera and music that could be used for a background are easily downloaded into a computer. Microsoft's Photo Story and Movie Maker as well as Apples' iMovie are software tools that could be used to create a digital story.

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Direct Instruction
SEE INSTRUCTION

Discovery-Expository Learning Continuum
SEE ALSO DISCOVERY LEARNING and GENERALITY and GENERATVE AND SUPPLANTIVE INSTRUCTIONAL STRATEGIES

Since discovery learning is a matter of degree, it is appropriate to think in terms of the discovery-expository learning continuum, which ranges from pure discovery to pure expository learning (Reigeluth & Keller, 2009). This continuum is closely related to the continuum from learner-centered to teacher-centered instruction (Reigeluth & Keller, 2009). Extreme discovery learning is a purely inductive approach in which the learners have to figure out on their own the meaning of concepts and relationships or how to perform the skills (e.g., solve the problem). Extreme expository learning is a purely deductive approach in which the meanings and skills are shown to the learner, so didactic methods such as presentation and demonstration are prevalent.

However, most instruction is neither purely discovery nor purely expository, but exists on some point along a continuum between the two. For example, many of the discovery learning approaches described in the literature consisted of some expository elements (Tuovinen, 2000). While students are engaged in discovery learning such as problem-based learning, didactic methods can be utilized in the form of scaffolding to help the students in the inquiry process and reflection on their learning. This kind of guided discovery, which exists in the middle of the continuum, has been proven to be more effective than minimally guided instruction by recent meta analyses (e.g., Strobel & Van Barneveld, 2009). Furthermore, one point on the continuum is not always better than the other, and any given point on the continuum is more appropriate than the others depending on the learning situation and purpose. For example, when there are a large number of students per teacher, and when there is a substantial amount of content to be learned, expository learning can be preferred because of its efficiency and effectiveness.

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Discovery Learning

SEE ALSO DISCOVERY-EXPOSITORY LEARNING CONTINUUM and OPEN EDUCATION

Discovery learning, on the one hand, refers to an epistemological theory *describing* how humans acquire new knowledge through active meaning-making, foreshadowed in the works of John Dewey and Jean Piaget, culminating in the “cognitive revolution” led by Bruner in the late 1950s—“an all-out effort to establish meaning as the central concept of psychology,” as Bruner later described it (1990, p. 2). “It focused upon the symbolic activities that human beings employed in constructing and in making sense not only of the world, but of themselves (p. 2).”

Discovery learning also refers to a family of instructional strategies, *prescribing* treatments in which learners create, integrate, and generalize new knowledge by exploring a problem space. These strategies are based on an inductive, as opposed to deductive, approach: learners are immersed in firsthand experiences from which they are guided toward understanding of some specified concept, rule, or cognitive strategy.

Discovery learning overlaps with the concept of inquiry-based programs, although inquiry advocates see their concept as going beyond the discovery of ideas, "where learners become systematically acquainted with scientific and logical rules used to verify those ideas (Massialas, 1985, p. 1416)."

Advocacy for discovery learning became a "movement" in education after publication of the findings of a 1959 post-Sputnik conference of three dozen scientists and educators on needed reform of math and science education (Bruner 1960). There followed two decades of national curriculum projects in "new physics," "new chemistry," "new math," "new social studies," and the like, similarly pitched toward teaching through more inductive, inquiry-oriented methods (Massialas, 1985). Producing the films, games, simulations, and other interactive resources needed to implement these curricula brought educational technology into the middle of the cognitive revolution (Molenda, 2008).

Since the 1960s interest in discovery methods has waxed and waned, not surprising in the light of equivocal research findings on their effectiveness. Since the 1990s advocacy for discovery learning has come under the rubric of constructivist learning environments (Jonassen, 1999) in the form of hypermedia, microworlds, problem-based learning, case-based scenarios, computer simulations, WebQuests, and other formats that feature exploration of problems embedded in rich contexts. Advocates claim that discovery learning methods stimulate curiosity, thus promoting intrinsic motivation; they give learners ownership of their knowledge; and they encourage creativity and problem-solving.

Recent critics have been harsh in pointing out the failures of unaided discovery (Mayer, 2004; Kirschner, Sweller & Clark, 2006). But a recent major meta-analysis gives qualified support for some discovery methods (Alfieri, Brooks, Aldrich & Tenenbaum, 2011). They conclude that "unassisted discovery" is indeed less effective than "explicit teaching," but that "enhanced-discovery methods led to greater learning than did comparison methods (p. 7)" They suggest that guidance in the form of feedback, scaffolding, and elicited explanation can help overcome the barriers of cognitive load and misunderstanding to which unassisted discovery are prone. This conclusion brings the argument full circle, hearkening back to Bruner's (1961) original recommendations, in which he warned that learners needed to be prepared for discovery activities and to be guided in the process.

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Discussion Boards
SEE TECHNOLOGICAL COMMUNICATION

Distance Education and Learning
SEE ALSO BLENDED LEARNING and INTERACTION and MOBILE LEARNING and OPEN EDUCATION

Terms such as distance learning, distance education, distributed learning, e-learning, online learning, and virtual schools are often used interchangeably, yet each term is distinct. As stated by Moore and Kearsley (2012), there is a “need to develop a critical awareness of the implications, assumptions, and the values portrayed by our choice of terms” (p. 289). For example, e-learning has an emphasis on communications technology, whereas distributed learning and distance learning have an emphasis on the learners’ location (Moore & Kearsley, 2012). Further, distance learning, as noted by Moore and Kearsley (2012), describes the learner’s interaction with the teacher at a distance. However, they caution that the term “distance learning” is used at times when the focus is on teaching and learning. As such, their focus is on education that “describes a relationship that has *two* sides, teacher and learner” (p. 2).

Simonson (2011) reports that over the years distance education has been defined from various perspectives (e.g., Delling, 1987; Garrison & Shale, 1987; Holmberg, 1985; Keegan, 1986; Moore, 1994; Perraton, 1988; Peters, 1988; Rumble, 1995). Simonson (2011) states that *distance* in distance education can have multiple meanings, such as the following: (1) “geographical distance, time distance, and possibly even intellectual distance” (p. 79); (2) “‘distance education’ has been applied to a tremendous variety of programs serving numerous audiences via a wide variety of media" (p. 80); and (3) "rapid changes in technology challenge the traditional ways in which distance education is defined" (p. 80).

According to Moore and Kearlsey (2012), distance education is multidimensional, and define it thus: "[d]istance education is teaching and planned learning in which teaching normally occurs in a different place from learning, requiring communication through technologies as well as special institutional organization" (p. 2). Similarly, Simonson, Smaldino, Albright and Zvacek (2012) defined distance education "as institution-based, formal education where the learning group is separated, and where interactive telecommunications systems are used to connect learners, resources, and instructors" (p. 32). In this definition, they argue that the following four components distinguish distance education:

1. Institutionally based—"not a self-study or a nonacademic learning environment" (pp. 32–33).
2. Separation of teacher and student—separation may be geographic, time, as well as intellectual separation between teachers and students (Simonson et.al., 2012, p. 34).
3. Interactive telecommunications—interaction through synchronous and asynchronous communication, as well as, learner interaction with other learners, the teacher and the resources/content (Simonson et.al., 2012, p. 34).
4. Connecting learners, resources, and instructors—the instructional design organizes the resources to support the learning experience, as well as, the instructor interacts with learners and resources to support learning (Simonson et.al., 2012, p. 34).

Simonson et al. (2012) state that if one or more these components are missing, "then the event is something different, if only slightly, than distance education" (p. 34).

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Distributed Cognition

SEE ALSO COLLABORATIVE LEARNING and INTERACTION and TECHNOLOOGY-ENABLED LEARNING

Distributed cognition was developed by Edwin Hutchins, a cognitive psychologist and anthropologist, when he investigated how navigation is coordinated on US navy ships around San Diego in the 1990s. From the perspective of educational psychology, Salomon (1993a p. xiii) argues that "people think in conjunction and partnership with others and with the help of culturally provided tools and implements". Hutchins (1995, p. xiii) understands distributed cognition from cognitive science as "the emphasis on finding and describing 'knowledge structures' that are somewhere 'inside' the individual [which] encourages us to overlook the fact that human cognition is always situated in a complex sociocultural world and cannot be unaffected by it."

As one of the branches of cognitive science, the fundamental insight of distributed cognition is that knowledge is confined not only to the individuals but distributed across an individual's social and physical environments; such cognition is best understood as a distributed process between humans and machines (physically distributed cognition) (Norman, 1993; Perkins, 1993) or between cognitive agents (socially distributed cognition). The key components of distributed cognition theory include embodiment of information that is embedded in representations of interaction, coordination of interaction among embodied agents and ecological contributions to a cognitive ecosystem. Salomon (1993b) pointed out that distributed cognition forms systems that consist of an individual agent, his or her peers, teachers, and socio-culturally formed cognitive tools.

The concept of distributed cognition can be used to describe how distributed units are coordinated by exploring the interactions among individuals, tool mediations involved, and the physical environments where the activities take place. From the perspective of distributed cognition, in cognitive process resources are located in a distributed way and shared in a social way, and therefore, individual cognitive resources can be extended facilitating individual accomplishments that could not achieved alone. A number of research methods are used in a distributed cognition approach; these include detailed analyses of video and audio recordings of real-life events, neural network simulations and laboratory experiments.

Distributed cognition is very powerful when used to analyze human-computer interactions and to analyze instructional technologies in terms of their dependence on the social and physical environments of individuals. In these cases, distributed cognition provides a more balanced theoretical framework to treat problem solving with technology in real work situations.

As a useful descriptive theoretical framework that describes human work systems in informational and computational terms, distributed cognition provides a stronger, clearer alternative model to understand the roles and functions of representational media as tool mediation, and has rich implications for the design of technology in the mediation of diverse activities. Distributed cognition has great potential to be applied in such field as computer-supported collaborative learning, computer-supported cooperative work, human computer interaction, instructional design, and distance learning. For example, Rogers & Ellis (1994) have used distributed cognition as an alternative framework to analyze and explain collaborative working in diverse computer-supported settings.

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Distributed Learning

SEE DISTANCE EDUCATION AND LEARNING and MOBILE LEARNING

Domains of Learning

SEE LEARNING TYPES

Dual Coding Theory

SEE ALSO GRAPHICS and MULTICHANNEL INSTRUCTION and VISUAL AND PICTORIAL LEARNING

Dual coding theory was first proposed by Paivio and then refined based on newer research (Paivio, 1971, 1986, 1991, 2007). According to Paivio, there are two separate systems in working memory that are specialized for the processing of either language information or nonverbal objects and events. The terms "logogen" and "imagen" were later adapted by Paivio (2007) to describe the representational units of language and nonverbal objects. These two systems function independently, that is, a stimulus such as dog could activate either system with the observer either recalling an image of a dog or the word "dog." Similarly, the two systems can work in parallel or simultaneously to process both the object (e.g., image) and verbal label. The conceptual peg hypothesis is an example of associative processing where two unrelated units (e.g., an image and a word) are linked (Paivio, 1971).

Mayer and his colleagues (Mayer, 2001; Mayer & Anderson, 1991; Mayer & Moreno, 2003; Moreno & Valdez, 2005) have extended and revised the dual coding theory to apply to both CBI and multimedia instruction. Mayer's (Mayer, 2001) theory of multimedia learning incorporates dual coding theory (Paivio, 1971), cognitive load theory (Sweller, 1999), and active processing (Wittrock, 1989) to design effective multimedia instruction.

Recently, dual coding theory has been used to frame instructional technology studies investigating diagrams and time compressed speech (Pastore, 2010), animation of concepts (Doymus, Karacop, & Simsek, 2010), and pictures and words in multimedia (Moreno & Valdez, 2005). Dual coding theory impacts the design of instruction and instructional technology research based on the finding that pictures are more easily recalled than concrete words (Paivio, 2007).

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E

Educational Design Research
SEE DESIGN-BASED RESEARCH

Educational Media
SEE ALSO AUDIOVISUAL INSTRUCTION and EDUCATIONAL TECHNOLOGY and MEDIA

The concept of media (plural) or medium (singular) can be considered almost synonymous with technology, though the latter suggests a broader process/product/system focus, while the former is delimited to the tool or product. Media, often considered the sole domain of journalism, became popular within the field of education, particularly with the theoretic perspective of Marshall McLuhan who argued for a broad definition of media as "extensions of man." His aphorism "the medium is the message" (McLuhan, 1964, p. 23) became an often quoted and well-known line of the last half of the twentieth century. McLuhan's aphorisms, mostly from the 1960s, have proved remarkably prescient, predicting a global village, Internet surfing, and even the tweet.

In the field of education, the term "educational media" expanded on the earlier (1940s) concept of "audiovisual education," itself an expansion of the 1920s term "visual education," and became ultimately a transition term towards the now commonly used "educational technology." In the USA, that transition was complete when the *Department of Audio Visual Instruction* changed its name to the *Association for Educational Communications and Technology* in 1970.

The term "educational media" has been mostly replaced now, but still can be found in several domains. Most notably, the International Council for Educational Media was founded in 1950 with the purpose of promoting what they called "educational media." Today, that organization has membership in approximately 30 countries. Its work includes an annual conference, and a refereed journal *Educational Media International*.

In a somewhat different direction, the term "media ecology" has gained some prominence. Neil Postman (1985) was among the major promoters and advocates of this term focusing on the idea of media as environment.

While the term "educational media" is no longer as popular as competing terms, such as ICT and educational technology, it is certainly a resilient term that continues to show up in the twenty-first century literature on educational technology. (See for example, Robinowitz, Blumberg, & Everson, 2004 and Flew, 2002.) Likewise, Laurillard (2002) continues to describe educational media "in terms of the nature of the learning activities they support: narrative, interactive, adaptive, communicative and productive" (p. 6). She then identifies these media as a range of "print, audiovisual, computer-based learning, teleconferencing, and Web-access" (p. 5).

Contemporary postmodern philosopher Jean Baudrillard (1983/1991) has argued that "The medium itself is no longer identifiable as such, and the merging of the medium and the message (McLuhan) is the first great formula of our new era" (p. 468).

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Educational Technology
SEE ALSO TECHNOLOGY

A definition of educational technology is problematic on several fronts. First, the term vacillates between the use of "educational" or "instructional." In general, "instructional" is the narrower term and is a subset of "educational" (AECT Task Force on Definition and Terminology, 1977). On the other hand, a different explanation is context-related, such that the term "educational" is more common in K-12 settings, while “instructional” is most often used in corporate settings (Seels & Richey, 1994). Historically, the term “educational technology” was preceded in the 1920s by the concept of “audiovisual education.”

Second, the common sense definition alludes to educational technology as a thing, a gadget, or a tool. In that sense, educational technology has been characterized as “the things of learning” (Armsey & Dahl, 1973. p. 21). Contemporary popular usage continues to see technology as a tool, even though the metaphor is not quite accurate.

Third, the term “media” is often used as a synonym for “technology.” Thus, we have “educational media” and “instructional media,” though these terms have become less common in current usage.

Fourth, new terms, especially “information technology” (IT) and “information and communication technology” (ICT) and “digital technologies” have become common within pedagogic and business environments. Curiously, these terms have dropped the explicit references to education or pedagogy, even though they are consistently used in a pedagogic environment.

Fifth, what used to be called “vocational education” has re-branded itself as “technology education,” not to be confused with “educational technology.” The two fields have simply inverted noun and adjective! While the two areas are not related, unsuspecting users may substitute the one for the other, thinking them synonymous.

The Association for Educational Communications and Technology (AECT) is one of the few professional organizations that continues to wrestle with the “educational technology” definition. Over the decades, that definition has continued to evolve. AECT’s 1977 definition focused on system: “Educational technology is a complex and integrated process of people, procedures, ideas, devices, and organization for analyzing problems and devising, implementing, evaluating, and managing solutions to those problems, involved in all aspects of human learning” (AECT Task Force on Definition and Terminology, 1977 p. 1). The 1994 definition selected the adjective *instructional* over *educational*, calling the concept a “theory and practice”: “Instructional technology is the theory and practice of design, development, utilization, management and evaluation of processes and resources for learning” (Seels & Richey, 1994, p.1). The current 2008 definition returns to *educational* technology, adds an explicit reference to performance technology, and provides an ethical slant: “Educational technology is the study and ethical practice of facilitating learning and improving performance by creating, using, and managing appropriate technological processes and resources” (Definition and Terminology Committee of the Association for Educational Communications and Technology, 2008, p. 1).

As technologies and pedagogies evolve, as social networking, globalization, and mobile/distant learning strategies become more common, there is little doubt that the next decade will be captured by yet another iteration, as scholars attempt to capture the dynamic and very fluid idea of the essence of educational technology.

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Elaboration Sequencing

SEE ALSO MENTAL MODEL PROGRESSION and SEQUENCING and SIMPLIFYING CONDITIONS METHOD

Elaboration sequencing is a macro level instructional strategy proposed by Elaboration Theory (Reigeluth, 1987; 1999). In the elaboration theory, different kinds of elaboration sequences are designed for different kinds of learning or expertise. Task expertise is goal-oriented (like engineering) and is promoted by the simplifying conditions sequence (Reigeluth, 1999, 2007; Reigeluth & Rodgers, 1980), while domain expertise is not goal-oriented (like physics) and is promoted by the conceptual elaboration sequence (Reigeluth, 1999, 2007; Reigeluth & Darwazeh, 1982) or the theoretical elaboration sequence (Reigeluth, 1999, 2007). It is also possible to use a combination of elaboration sequences (Beissner & Reigeluth, 1987, 1994).

The simplifying conditions sequence is an extension of the procedural elaboration sequencing (Reigeluth & Rodgers, 1980), which is "a sequencing method that proceeds from simpler versions of a complex procedure to more complex versions" (Reigeluth & Keller, 2009, p. 38). The simplifying conditions sequence has been extended to offer guidance for the design of heuristic tasks and tasks that have a combination of procedural and heuristic elements (Reigeluth, 2007).

Conceptual elaboration sequencing "starts by teaching or discovering the broadest, most inclusive, and general concepts that the learner has not yet learned, and proceeds to ever more narrow, less inclusive, and more detailed concepts, until the necessary level of detail has been reached" (Reigeluth, 1999, p. 438). It is based on the notion of cognitive scaffolding (Ausubel, 1968) or cognitive structure, and schema theory also supports this notion as well (Anderson, 1984). It can be used with either discovery or expository instruction.

Lastly, theoretical elaboration sequencing is intended for instruction focusing on interrelated principles, such as a biology course focusing on life cycles. Theoretical elaboration sequencing starts by "teaching the broadest, most inclusive, most general principles that the learner has not yet learned which are also the simplest principles and generally the first to have been discovered, and it gradually progresses to ever more narrow, less inclusive, more detailed, more precise principles which are also more complex and were generally discovered later" (Reigeluth, 1999, p. 440).

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Elaboration Strategies

SEE ALSO ADVANCE ORGANIZER and COGNTIVE STRATEGIES and ELABORATION, TYPES OF

As a specific cognitive strategy, elaboration is the process through which the learner builds an internal and stable connection between the content to be learned and previous knowledge. This connection takes the stress off of working memory, since it creates efficiency of learning and memory. Generally, the goal of an elaboration strategy is to help students use elements of what is to be learned and expand upon them. Diverse elaboration strategies have been developed for the formation of cognitive structures that aid in the solution of real-life problems. These strategies include paraphrasing, summarizing, creating analogies, generative note-taking, and question answering (McKeachie, Pintrich, Lin, & Smith, 1986; Weinstein & Mayer, 1986; Pintrich, 2002).

Elaboration strategies are one of the most important components in the framework of elaboration theory which was proposed by Charles Reigeluth and his colleagues in the 1970s. This theory provides guidance for scope and sequence decisions in instructional design (Reigeluth, 1999). As an instructional design theory, elaboration theory argues that content to be learned should be organized in the order from simple study skills to complex thought processes, while providing a meaningful context in which subsequent ideas can be integrated. Abu & Flower (1997, p. 2) state that "the elaboration theory suggests that one of the most effective means of learning is to explain the material to someone else." Moreover, elaboration theory can be directly applied to cooperative learning as Slavin has proposed (1987).

Before elaboration theory was proposed by Reigeluth, American educational psychologist David Ausubel (1968) developed several elaboration strategies as a part of his meaningful learning theory. He used the concept of "advance organizers" to describe how learning occurs and to serve as a basis of instructional sequencing which leads to meaningful learning.

Since elaboration strategies help students establish bridges from information previously acquired to information to be learned, they can be used as powerful tools for teaching and learning. Elaboration strategies have been widely used in teaching and learning practice. Bernt & Bugbee (1990) found that elaboration strategies were used by 50–75 % of the students in educational environments at different achievement levels. In another study, Chuang & Chen (2002) investigated the effects of elaboration strategies in a hypertext environment, and found that there were statistically significant differences between the control group and the experimental group in terms of students' achievements on learning facts and concepts.

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Elaboration Theory

SEE ELABORATION SEQUENCING and ELABORATION STRATEGIES

Elaboration, Types of

SEE ALSO ELABORATION STRATEGIES

According to Leshin, Pollock and Reigeluth (1992) “elaborations provide detailed information that links a new concept with relevant prior knowledge” (p. 206), and they are especially useful for conceptual learning. There are five types of elaborative relationships: superordinate, coordinate, subordinate, experiential, and analogical relationships, and each type requires different instructional tactics

(Leshin et al., 1992). A superordinate relationship presents a higher level of concept than the new concept. The higher level of concept is broader and more inclusive. Providing the context of the new concept is appropriate. A coordinate relationship presents a concept within the same level. It helps learners to show similarities and differences of the prior knowledge and the new concept by compare and contrast. A subordinate relationship presents the parts and the kinds of the new concept. It helps learners to analyze the new concept into its parts or kinds. An experiential relationship presents a case or instance of the new concept. Providing examples helps learners understand the relationship. An analogical relationship presents similarities and differences between the new concept and a concept outside the content. The difference between analogical and coordinate relationships is whether the compared concept is inside or outside the content area. Like coordinate relationships, analogical relationships are best taught through compare and contrast.

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e-Learning
SEE DISTANCE EDUCATION AND LEARNING and MOBILE LEARNING

Electronic Performance Support System
SEE ALSO JOB AID and JUST-IN-TIME TRAINING

Electronic performance support systems (EPSS) are computer-delivered performance improvement interventions that guide and inform task completion (Barker, van Schaik, & Famakinwa, 2007). The salient features of EPSS interventions are deployed "while the work is being performed rather than at some arbitrary point in time beforehand as with training" (Nguyen & Klein, 2008, p. 96). EPSSs are repositories of just-in-time information, resources, and tools to enable a performer to better execute a specific task in a work context (Yuxin & Harmon, 2006). In sum, an EPSS is "a highly sophisticated technological job aid" (McManus & Rossett, 2006, p. 8) which enables workers to improve "their performance and acquire relevant knowledge and skills while performing tasks" (Chen, C., Hwang, Yang, Chen, S. & Huang, 2009, p. 421). For example, a teacher could use an EPSS to find activities for lesson a plan; a technician could access an EPSS to find repair procedures; an event planner could use it to locate activities for a group.

EPSSs work well for tasks defined that meet certain requirements. Because EPSSs typically require labor-intensive design, impeccable implementation, and expensive technology, they are best used for tasks involving stable content or processes. In addition, the tasks should be frequently performed by a large number of people who have access to the electronic delivery system. Furthermore, the organization must have the resources required to create, implement, and maintain the system as content changes.

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Emoticon
SEE ON-LINE BEHAVIOR

Empowerment Evaluation
SEE EVALUATION MODELS

Enterprise
SEE LEARNING TYPES

e-Portfolio
SEE ALSO ASSESSMENT

The term electronic portfolio (e-Portfolio) refers to a digital collection of an individual's work typically used to support personal development, formative and summative assessment, and/or work-related CVs (Tosun & Baris, 2011). Since the

1990s, depending on one's access to multimedia authoring technologies, electronic options have supplemented traditional portfolio development. The word *portfolio* comes from the Latin—"portare" (to carry) and "folium" (papers, typically assembled into a criterion-based collection). Digitizing portfolios has helped address the concerns of storage of bulky artifacts, dissemination of content to a larger audience, and re-purposing of content to extend a portfolio's use.

Literature on portfolios (Barrett, 2010; Fox, Kidd, Painter & Ritchie, 2006; Jafari & Kaufman, 2006) is rife, suggesting their value rests in:

> … constructing, presenting, and reflecting on the contents or the evidence of the portfolio. This inevitably involves sorting, gathering, and reflecting on the work of teaching—considering lessons taught, reviewing samples of the work of one's students, defining effective teaching moments or failures—and articulating why these are important to one's own philosophy and practice. Validation and understanding emerge through portfolio conversations with peers and mentors, the presentation of portfolio evidence, and the recognition of the new knowledge of practice generated through this process (Lyons, 1998, p. 5).

However, practice suggests evidence of meaningful reflection has been limited, and the focus on the selection of quality items tends to privilege product over process (Crichton & Kopp, 2009). Barrett (2010), a recognized champion of the e-Portfolio movement, suggests research has started to address this concern, and she highlights eDOL: Electronic Documentation of Learning (Smits, Wang, Towers, Crichton, Field, & Tarr, 2005). eDOL piloted the use of BLOGS as "a repository from which students drew reflections and evidence to support the development of ePortfolios" (Crichton & Kopp, 2009). The use of electronic journals: (1) enables dialogue and reflection (Greenberg, 2006), (2) supports the ongoing collection of digital artifacts in their raw/rough state, (3) invites discussion about the artifacts, (4) unifies activities across a course/program, and (5) helps students to develop their portfolios from a personal repository that supports learning over time. Barrett (2010) suggests the addition of electronic journals has added to the e-Portfolio literature emphasizing process over product.

An e-Portfolio "is an electronic collection of evidence that shows your learning journey over time. Portfolios can relate to specific academic fields or your lifelong learning. Evidence may include writing samples, photos, videos, research projects, observations by mentors and peers, and/or reflective thinking" (Barrett, 2010, p. 292). E-portfolios typically serve the purpose of assessment for learning, narrative of discovery, tools for reflection, and a source for the development of work related CVs.

Susan Crichton

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Also See Additional Resources for Further Information on this Subject

Ethics

SEE ALSO CHILDREN'S INTERNET PROTECTION ACT and CHILDREN'S ONLINE PRIVACY PROTECTION ACT and ONLINE BEHAVIOR and PROFESSIONAL STANDARDS

The latest definition of educational technology promulgated by the Association for Educational Communications and Technology (AECT) recognizes the importance of ethics: "Educational technology is the study and ethical practice of facilitating learning and improving performance by creating, using, and managing appropriate technological processes and resources" (Yeaman, Eastmond, Jr. & Napper, 2008). *Tech Trends* has long contained columns on ethics: "Ethics Today," "Ethically Speaking," and "Professional Ethics" were expanded and included in Paul W. Welliver's (2001) *A Code of Professional Ethics*.

Codes of ethics establish a framework for professional behavior and evaluation. AECT adopted its latest code of ethics in 2001. All members of AECT must adhere to this code, which stresses members' commitment to the individual, society, and profession (Association for Educational Communications and Technology, 2007). The AECT code is not meant to be casuistic, but intends to move the discussion on ethics beyond mere technical concerns. The present code is oriented towards program delivery and product development in graduate programs in educational technology.

The educational technology practitioner must understand ethical issues that arise beyond the local production facility. The Internet has raised unique ethical challenges, particularly the question of privacy in a public world. Recent legislation seeks to balance freedom of speech from the unethical use of information (e.g., Children's Online Privacy Act, 2000 and Children's Internet Protection Act, 2001). Technology professionals are responsible for the bytes of information flowing from their work states. The ethical concerns of yesterday, such as intellectual property rights and privacy concerns have become today's legal issues.

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Evaluation
SEE ALSO INSTRUCTIONAL DESIGN MODELS and EVALUATION MODELS

There are a myriad of evaluation definitions reported in the literature. Some focus on a social science research perspective; some on the use of evaluation findings; some on evaluative activities (Russ-Eft & Preskill, 2001). Others focus on evaluating impact (Guerra-Lopez, 2007), address utilization-focused perspectives (Patton, 2008), performance evaluation approaches (Guerra-Lopez, 2008), and training evaluation (Phillips, 1997). There are other areas of foci too. Evaluation is used in education, in public and nonprofit sectors, business and industry, health arenas, and in other segments of society. Michael Scriven offers one of the earliest and commonly used definitions:

> Evaluation refers to the process of determining the merit, worth, or value of something…. The evaluation process normally involves some identification of relevant standards of merit, worth, or value; some investigation of the performance of evaluands (whatever is being

> evaluated) on these standards; and some integration and synthesis of the results to achieve an overall evaluation or set of associated evaluations (Scriven, 1991, p. 139).

Whatever the perspectives and however they are focused, evaluation is systematic, planned, and purposeful, a means for data collection and decision making, and a rendering of merit, worth, or value. (Russ-Eft & Preskill, 2001).

There are three types of evaluation—formative, summative, and confirmative. Formative evaluation is "a judgment of the strengths and weaknesses of instruction in its developing stages, for purposes of revising the instruction to improve its effectiveness and appeal. The evaluation is conducted by collecting data about the instruction from a variety of sources, using a variety of data gathering methods and tools" (Tessmer, 1993, p. 11). Fitzpatrick, Sanders & Worthen (2011) concur: "the primary purpose is to provide information for program improvement" (p. 20). It is conducted during design, development, and pilot or field testing. The customers are primarily design team members, decision makers and stakeholders.

Summative evaluation is conducted at the end of a program or a process for determining short-term results, immediate reactions or immediate competence. "It provides information to enable decision makers to decide whether to continue the program, or consumers to adopt it" (Fitzpatrick, Sanders & Worthen, 2011, p. 24). It is conducted during or immediately after full implementation.

Dessinger & Moseley (2004) say that confirmative evaluation "goes beyond formative and summative evaluation to judge the continued merit, value, or worth of a long-term program" (p. 204). It is used to determine the utility (Do we still need this?), the effectiveness (Does this still work?), and the efficiency (Is this still the best way to do it?) of program performance. Time ranges from 3 to 12 months or more after full implementation and the primary customers are decision makers and users and design team members.

Dessinger & Moseley (2010) suggest the notion of full-scope evaluation by adding meta-evaluation to formative, summative and confirmative. It is done after confirmative, and it judges the validity and reliability of the other three types. It provides insight to the evaluator for quality improvement and lessons learned.

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Also See Additional Resources for Further Information on this Subject

Evaluation Models

SEE ALSO EVALUATION and INSTRUCTIONAL OBJECTIVES

Evaluation is a systematic process for collecting and analyzing data about organizations, programs, processes, or products. The purpose is to enhance decisions related to the continuation or improvement of that organization, program, process, or product. Thus, summative evaluations, which are "conducted after completion of the program…and for the benefit of some external audience or decision maker" (Scriven, 1991, p. 340), include monitoring and auditing, outcome evaluations, impact evaluations, and performance measurement. Formative evaluations, in contract, are typically "conducted for the purposes of program or product improvement by in-house staff" (Russ-Eft & Preskill, 2009, p. 18). Developmental evaluations "describe certain long-term, partnering relationships with clients who are, themselves, engaged in ongoing program development" (p. 312).

Various models and approaches have been developed for evaluation, and a few of these will be described here. The models and approaches tend to differ in terms of: (a) focusing questions, (b) the intended users of the findings, (c) the degree of stakeholder involvement, (d) some underlying assumptions, and (e) primary methods. The following paragraphs will highlight a few of these models.

The behavioral objectives approach (Bloom, et al., 1956; Mager, 1962; Popham & Baker, 1970; Tyler, 1935) focuses on examining whether a program was achieving its objectives or outcomes. Managers are seen as the primary users of the findings, and stakeholder involvement is limited. Quantitative data are preferred, and achievement tests and performance data are primarily used.

The four-level evaluation taxonomy (Kirkpatrick, 1959a, b, 1960a, b, 1994) focuses on examining one or more of the following outcomes: reactions, learning, behavior, and results. As with the behavioral objectives approach, managers are viewed as the primary users of the findings, stakeholder involvement is limited, and quantitative data are preferred. In this, however, the quantitative data consist of reaction sheets, learning tests, behavioral surveys or observations, and production data.

Empowerment or transformative evaluation (Fetterman, 1994; Fetterman & Wandersman, 2004; House, 1993; Mertens, 1998, 2009) focuses on the question of information needs to foster improvement and self-determination, primarily of community members. A high level of stakeholder involvement is required, given the political agenda to empower the stakeholders. Mixed methods can be used, but most of these evaluations use qualitative data.

Theory-driven evaluation (Bickman, 1987; Chen, 1990, 1994, 2005; Donaldson, 2007; Weiss, 1997) focuses on asking how the program should work and what the underlying assumptions are. There is a moderate level of stakeholder involvement, primarily because the stakeholders tend to be government agencies. Mixed methods can be used, but most of these evaluations use quantitative methods.

The strengths and assets or success case approach (Brinkerhoff, 2003, 2005, 2006; Preskill & Catsambas, 2006) focuses on identifying the successes and the successful cases in a program. The idea is to identify what is working and why it is working. The primary stakeholders can be management or organization members or both, and the stakeholder involvement ranges from moderate to high. Qualitative methods are preferred in order to obtain the narratives and stories that describe success and the factors leading to success.

Details on the models described above and several other models and approaches can be found in Russ-Eft and Preskill (2009).

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Also See Additional Resources for Further Information on this Subject

Events of Instruction

SEE ANALOGY and COGNITIVE LEARNING THEORY and CONDITIONS OF LEARNING and FEEDBACK and GENERATIVE AND SUPPLANTIVE INSTRUCTIONAL STRATEGIES and PREREQUISITE SKILLS

Examples and Non-Examples

SEE ALSO LEARNING TYPES

Using examples and non-examples is a micro-level instructional strategy that is highly associated with the application level of Bloom's Taxonomy (Bloom, Engelhart, Furst, Hill & Krathwohl, 1956; Krathwohl, 2002), and more specifically with teaching concept-classification (Merrill & Tennyson, 1975).

The example–non-example strategy is defined as "the use of instances of a concept that illustrate key attributes of the concept in contrast with instances that do not illustrate the key attributes of the concept, to aid the learner in discrimination regarding salient characteristics or dimensions of the concept" (Reigeluth & Keller, 2009, p. 37). Thus, the strategy is often associated with concept classification, which is described as generalization within a class and discrimination between classes (Mechner, 1965; Reigeluth, 1999a). As Gagné (1985) indicated, concepts are important because they are the building block of most cognitive capabilities.

Examples and non-examples are usually utilized in the Generality—Example—Practice—Feedback routine for learning concept classification (Merrill & Tennyson, 1975; Reigeluth, 1999b). After prototype formation (Tennyson, 1973), learners should learn the commonalities (critical characteristics) of the concept class and also learn how to use them to distinguish members of the class from nonmembers. One way to achieve this goal is to provide them with examples of the class. Learners need to learn how examples are different from each other (variable characteristics) and still be in the class, which is done by providing them with divergent examples—ones that are as different as possible from each other. This promotes *generalization* to all members of the concept class. It is also important to help learners discriminate members of the class from nonmembers.

The use of non-examples is not effective for understanding concepts when used without examples (Bruner & Anglin, 1973; Bruner, Goodnow & Austin, 1953; Hovland & Weiss, 1953; Smoke, 1933), whereas non-examples have a useful effect on facilitating concept classification when used with examples (Cohen & Carpenter, 1980; Klausmeier, 1976; Tennyson, 1973).

One stream of research on examples and non-examples is how to combine them, and it has been found that learning is enhanced when students study instructional materials that incorporate a "rational sequence" of examples and non-examples (Klausmeier, 1976), which consists of at least two pairs of instances, each consisting of a matched example and non-example with consecutive pairs divergent (Klausmeier & Feldman, 1975; McMurray, Bernard & Klausmeier, 1974; Tennyson, 1973).

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Expert System

SEE ALSO EXPERTISE and KNOWLEDGE MANAGEMENT and SIMULATION

An expert system is a computer program that emulates a human expert or actively supports a human problem solver or decision maker to assist that person in performing as an expert. Expert systems were first developed in the 1960s as part of the emerging discipline known as artificial intelligence, which dates back to John McCarthy's (1959) work on machine intelligence and computer languages (e.g., ALGOL and LISP) to solve complex problems. (See also Nilsson, 2010).

The software known as HEURIST DENDRAL developed in the 1960s by Edward Feigenbaum and Joshua Lederberg demonstrated that a computer program with substantial and executable domain knowledge could elucidate the structure of complex chemical compounds (Lindsay, Buchanan, Feigenbaum, & Lederberg, 1980). The success of the Dendral project established a path which nearly all expert systems have followed—namely the creation of a model of the domain knowledge used by expert problem solvers and decision makers. The domain model takes the form of one or more sets of rules which comprise the knowledge base of an expert system. An expert system also needs an inference engine which can analyze a specific situation or state and determine which rules might be applied and then select a rule to apply that is most likely to produce a desired outcome (Biondo, 1990; Hayes-Roth, 1984). There are many different ways to construct the knowledge base, the situation analyzer and the inference engine.

Expert system technology has been applied in various learning and instructional contexts. Intelligent tutoring systems are expert systems that are intended to emulate the behavior of a skilled human tutor, analyzing what a student knows and does not know, diagnosing specific problems, and then searching through a domain knowledge base to select an appropriate instructional resource or learning activity (Psotka & Mutter, 1988). A recent development in the application of expert systems to learning and instruction involves the creation of computer simulations of student thinking, or cognitive tutoring systems (Anderson, Corbett, Koedinger & Pelletier, 1995).

Expert systems represent a form of adaptive technologies that can be used to support personalized learning as well as dynamic formative feedback (Pirnay-Dummer, Ifenthaler & Spector, 2010; Savenye & Spector, 2010). In general, expert systems and adaptive technologies in the domain of educational technology have and are likely to continue to support the ability of educational technologists, evaluation specialists, instructional designers, teachers, and trainers to consistently perform at high levels of expertise even when they may lack some of the knowledge and experience (Spector, 2008; Spector & Kim, 2012).

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Also See Additional Resources for Further Information on this Subject

Expertise
SEE ALSO DESIGNER DECISION-MAKING RESEARCH and PRACTICE

Expertise is a specific area of research within learning and cognition, where performance by experts in some domain is examined in contrast to performance on the same activities by beginners or relative novices. The question has been examined across a variety of skills, such as athletic performance and other motor skills (e.g., typing, telegraphy), creative arts (e.g., music, writing), games (e.g., chess), science, and many other endeavors.

At one time such performance advantage might have been explained mainly in terms of some intellectual advantage; however, that explanation does not seem to apply very well to some domains (e.g., sports), and in other domains the correlation with measures of intelligence is not impressive. However, even Galton's (1979/1869) early interest in eminence acknowledged factors other than innate gifts, in that motivation and effort were necessary for the realization of eminent performance by an individual.

In one of the pioneering studies, Simon and Chase (1973) introduced what is referred to as the "10 year rule," such that no one attained the level of chess master without a decade of intense preparation and experience with that game. This degree of required practice was confirmed by others for chess masters, and it has been observed many times since for numerous other domains. The 10-year rule (10,000 h) illustrates the interaction of talent and effort, heredity and environment. It is not that experience per se guarantees expert levels of performance, but that it is an essential component, and importantly one that is under the control of an aspirant.

The typical characterization today attributes the expert's advantage to several years of practice, building on some innate inherited capacities that fit the task or skill (e.g., Ericsson, Krampe, & Tesch-Römer, 1993). The result is a different style of information processing, decision making, and performance by experts, with this advantage limited to that specific domain (Ericsson, 1996; Ericsson, Charness, Feltovitch, & Hoffman, 2006; Ericsson, 2009). For example, novices are found to approach a task with set rules and strategies, and consciously monitor performance, whereas experts perform less consciously, displaying automaticity. Novices tend to treat aspects of the situation as separate and equally important, whereas experts process larger units of information. Experts have a greater range of strategies, and are more flexible in changing strategies as required for success. Novices are more likely to be distracted by extraneous factors, such as anxiety, whereas a skilled performer is more able to maintain focus.

Given the well-established importance of practice, much current research is focused on the characteristics of "practice" that are effective at achieving one's potential. Practice must be more than repetition per se, so just what is it about practice that can be deliberately incorporated into an education or training regime? Further, how can the benefits of deliberate practice be measured to document improvement in expertise?

John Mueller

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External Conditions of Learning

SEE CONDITIONS OF LEARNING

Extraneous Cognitive Load

SEE COGNITIVE LOAD

Extrinsic Motivation

SEE MOTIVATION

F

Fact
SEE LEARNING TYPES

Far Transfer
SEE TRANSFER

Feedback
SEE ALSO PRACTICE and PROGRAMED INSTRUCTION and PROMPTING

Feedback is "information on goal attainment designed to … monitor and evaluate … progress in achievement of desired accomplishments" (Spector, Merrill, van Merriënboer, & Driscoll, 2008, p. 820). Feedback is fundamental to learning (Hattie & Timperley, 2007) and it is found in almost every aspect of instructional design. The universality of feedback is not surprising given the fact that it is a primary element in each of the theoretical bases of instructional systems design (ISD) (Richey, 1986). It is feedback's ability to improve instruction and enhance learning that makes it an essential ingredient in design and one that is applied in a variety of instructional and noninstructional settings.

Feedback, in the form of formative evaluation, is a staple in instructional design models. Regardless of how a model employs formative evaluation or how it is graphically presented, the iterative nature of ISD relies on information to improve the process (Dick, Carey & Carey, 2009). Designers and developers use subject matter expert reviews, learner walk-throughs, and pilots with the goal of identifying deficiencies in the design and improving the quality of the program. Feedback is also a central tenet of most performance improvement systems. Tosti (2006) suggests that "employees cannot reach a basic level of competence through instruction alone but that work fluency requires practice and feedback" (p. 5). Performance improvement tools such as 360° evaluations, coaching and performance appraisal systems all utilize the corrective influence of feedback.

Feedback, in an instructional context, focuses on correcting a learner's performance. Gagné's Events of Instruction prescribe a micro-design model and event seven directs instructors to "provide feedback about the performance correctness" (Gagne, Wagner, Golas & Keller, 2005, p. 105). Feedback reinforces the learning and prompts the learner to adjust and correct. In instructional settings, learners are generally viewed as the "receivers" of feedback. Yet Lee, Lim and Grabowski (2010) modify this relationship and train learners to become providers of their own feedback. They use "metacognitive feedback" as a strategy to enhance learners' self-regulation.

There is little disagreement on what feedback is, the role it plays to guide instruction, and the value it brings to learning. There is, however, some debate over the best way to provide feedback (Shute, 2008). The increase in e-learning has renewed interest in variables such as timing, specificity, and the format of feedback. In an e-learning context, feedback is currently discussed as e-assessment and technology-mediated feedback (Miller, Doering & Scharber, 2010) and e-feedback (Rigas & Alharbi, 2011). Instructional designers can provide immediate, targeted feedback to correct learner performance automatically as learning management systems become more sophisticated (Sabry & Barker, 2009). These systems move beyond a simple "correct" vs. "incorrect" response. Detailed feedback can be preprogramed based on anticipated learner responses. This automated feedback can include links back to related instructional content, links to additional resources to reinforce the learning, or links to content outside the scope of the instruction to remediate deficit skills (Wieling & Hofman, 2010). The nature and timeliness of feedback also influences perceptions of student satisfaction in addition to improving learning (Espasa & Meneses, 2010). Learners at all stages require feedback and instructional designers will continue to find creative methods to build timely, targeted feedback into their design to meet this need.

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Field Dependence and Independence

Witkin, Moore, Goodenough, & Cox (1977) described and measured cognitive styles as the degree to which a person may be field dependent or independent. Field dependence and independence (FDI) has been defined as an individual difference in the spatial perception that is a pervasive expression of emotion, personality, and neuropsychological processes (Korchin, 2001). Unlike learning styles, cognitive style affects spatial learning (Rittschof, 2010). FDI influences emotions, personality traits, and psychological processes (Korchin, 2010). The effect is so pronounced that FDI has been included as a construct in information-processing models (Tsitsipis, Stamovlasis, & Papageorgiou, 2010).

Given the prominence of FDI, efforts have been made to accurately measure it. One example is the Group Embedded Figures Test (GEFT) which can reliably measure a respondent's FDI with paper and pencil. The test reveals if the respondent's cognitive style is predominantly determined by visual cues, that is field-dependent, or by bodily cues, that is, field-independent (Witkin, et. al., 1977). The GEFT, a tested measure of visuo-spatial working memory differences, has provided evidence that FDI is an observable, measurable phenomenon that can predict learning outcomes. FDI, historically associated with cognitive styles and less appropriately with learning styles, continues to prompt studies with implications for instructional design (Rittschof, 2010). The future question for FDI researchers is, can "interactive learning environments be developed to help assess and improve student's visuo-spatial working memory" (Rittschof, 2010, p.111).

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Forgetting

SEE MEMORY

Formative Evaluation

SEE ASSESSMENT and EVALUATION and EVALUATION MODELS and FEEDBACK

Four-C Instructional Design

SEE INSTRUCTIONAL DESIGN MODELS

Four-Level Evaluation Model

SEE EVALUATION MODELS

Front-End Analysis

SEE ANALYSIS

Full-Scope Evaluation

SEE EVALUATION

G

Game-Based Learning

SEE DIGITAL GAME-BASED LEARNING

Game Design

SEE ALSO DIGITAL GAME-BASED LEARNING and INSTRUCTIONAL DESIGN MODELS and VIRTUAL WORLDS

Educational Technology literature describes "game design" from several perspectives, including:

- The domain of game creation.
- Models and frameworks of designing and integrating games into learning.
- Examinations of how instruction and instructional design can inform and be informed by game design.
- Examinations of learners as game designers.

It is important to note that, generally speaking, when authors describe "game design" they typically are referring to the entire design process (including, for example, development and testing) in much the same way the term "instructional design" encompasses the entire process, rather than the narrower view of design as only a planning exercise.

In *Rules of Play*, Zimmerman and Salen (2004) describe design in general as "the process by which a designer creates a context, to be encountered by a participant, from which meaning emerges" (p. 41). Zimmerman (2008) later elaborates, describing the game designer as a creator of structure through which players create the play experience and also create the meaning within that experience. Henry Jenkins (2004) describes game designers as "narrative architects" (p. 118), creating worlds that tell stories, store memories, and enable players to both experience and create the story of the game experience.

One approach taken by some experienced instructional designers is to examine overlaps between game design and instructional design, and to describe specific design frameworks and models for creating games for learning (Echeverria, et al., 2011; Mariaais, Michau, & Jean-Phillipe, 2012). Dickey (2005) describes parallels between traditional instructional design, engaged learning principles and game design, especially highlighting those elements of game design that can inform the design of other kinds of interactive learning environments. In the early days of research in this field, Richard Duke (1980) proposed a standardized nine-step approach to designing serious games and simulations including elements found in traditional instructional design models such as written specifications and problem identification (analysis), selecting components and planning the game (design), building the game (development), testing and evaluation (implementation and evaluation). More recently, Gee (2006) does this in a much broader sense by examining the principles of learning he finds in the design of good video games, and describing how these principles apply to other kinds of learning experiences, be they digital or analog, in-school or out-of-school.

Rieber, Barbour, Thomas, and Rauscher (2009) make an explicit reference to learners as game designers by describing experiences through which students learn subject matter and design by creating games using simple tools such as PowerPoint. Games (2010) blends game play and game design by describing tools that immerse learners in the language and practice of game design, thus enabling creative expression, technology literacy, and the development of a "designer mindset" (p. 31). Similarly, Peppler and Kafai (2007) suggest that game design by learners reflects an increasingly participatory media culture.

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Games, Types of
SEE DIGITAL GAME-BASED LEARNING

Gap Analysis
SEE ANALYSIS and NEEDS ASSESSMENT

Gateway
SEE INFORMATION GATEKEEPER

Generality
SEE ALSO DISCOVERY-EXPOSITORY LEARNING CONTINUUM

Generality is a micro-level instructional strategy for application-level learning in Bloom's taxonomy (Bloom, Engelhart, Furst, Hill, & Krathwohl, 1956; Krathwohl, 2002). It is known that application-level learning is most effective when providing the learner with generality, examples, and practice, not necessarily in that order (Reigeluth & Darwazeh, 1982). According to Merrill, Reigeluth and Faust (1979), "the generality is a statement which applies to more than one instance" (p. 29).

The generality can be used in conceptual, procedural, and causal learning. In conceptual learning, the generality is a definition of the concept (Merrill et al., 1979). According to Merrill (1983), a definition of a concept consists of "the name of the concept, a superordinate class, a list of the intersecting attributes that define the concept, and the nature of relationship between those attributes" (p. 315). Suppose a learner tries to achieve the application level of the concept, *mammal*. That is, the learner wants to apply his/her knowledge in order to discern mammals from nonmammals. In an expository approach, the learner is given a definition of mammals, like "fur-bearing vertebrate animals" (as well as examples, non-examples and practice to learn to use the generality). In a discovery approach, the learner is given examples and non-examples that help her to discover the generality (critical characteristics).

In procedural learning, the generality is a set of steps or algorithms (Merrill, 1983). According to Merrill (1983) the generality of a procedure consists of "the goal or outcome to be produced by the process, the name of the procedure, some identification of each of the steps involved, some device to indicate the order in which those steps occur, a distinction between process steps and decision step, and some indication of alternatives that might result from a particular decision in the procedure" (p. 315). An example is the procedure for adding fractions (Reigeluth, 1999).

In causal learning, the generality is a proposition (Merrill, 1983). According to Merrill (1983), a proposition consists of "the name of the principle, some identification of the component concepts that comprise the principle, and some statement of the causal relationship" (p. 315). Reigeluth (1999) identified the law of supply and demand as an example and suggested three ways to apply a causal principle: prediction, explanation, and solution. Prediction occurs when the learner forecasts what will happen given a particular causal event. Explanation occurs when the learner explicates the cause of a given event (effect). Solutions occur when the learner selects the necessary actions (causes) to bring about a desired effect (a solved problem).

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Generative and Supplantive Instructional Strategies

SEE ALSO DISCOVERY-EXPOSITORY LEARNING CONTINUUM and LEARNER-CENTERED INSTRUCTION

The definition of generative and supplantive instructional strategies emerged from seminal works of Merlin Wittrock and Ernest Rothkopf. Both researchers drew conclusions about effective instructional strategies based on their being "mathemagenic," that is, "that which gives birth to learning" (Rothkopf, 1970, p. 325), and more specifically, those activities that engaged learners in active construction of knowledge (Wittrock, 1974). Mathemagenic strategies, often misaligned with only supplantive strategies, were meant to refer to "any instructional event [which] depends critically on what the learner does when the event occurs," including overt behavioral and covert mental activity (Rothkopf, 1996, p. 879). From this foundation, Smith & Ragan (2005) conceptualized a continuum of learning strategies that was marked by the degree to which a learner (purely generative) or the instructor (purely supplantive) creates the organization, conceptualization, and elaboration of knowledge.

Generative instructional strategies are often called learner generated, learner initiated, learner supplied, or active learning because of their defining characteristics of being learner-centered, active, and constructive. Learners generate their own understanding by building mental models overtly revealed through their own organizational, conceptual, elaborated, and integrative representations. The corresponding instructional strategies prompt learners to create these representations.

Supplantive instructional strategies are often called instructor-provided because of their defining characteristics of being instructor-centered, generated, and supplied. Instructors select and generate the organizational, conceptual, elaborated and integrative representations that are given to the learners to support their learning. This instruction is also often called passive instruction, found in expository instruction (Richey, Klein, & Tracey, 2011).

Ragan, Smith & Curda (2008) applied these definitions in their conditions-based ID theory to Gagné's Events of Instruction. They suggest that the locus of information processing, either generative, supplantive or some combination, be strategically selected by considering "context, learner, and learning task" (p. 392). Available time, prior knowledge, cognitive strengths, motivation and complexity of the task, are specific factors to consider when selecting generative/supplantive strategies. Lee, Lim, & Grabowski (2008) add "self regulation skill during the knowledge generation process" as an additional factor to their selection criteria (p. 122).

Supplantive instruction is often considered to be cognitively passive, and therefore, less effective than generative instruction. However, Mayer (2009) presents an alternative perspective based on an extensive research base. He outlined two dimensions important to understanding the effective use of active/passive instructional strategies. One dimension represents a level of overt behavioral activity required of a learner; the second dimension represents a level of cognitive activity. Through this matrix, he argues against concluding that high behavioral activity (generative) will automatically result in high cognitive activity, or that low behavioral activity (supplantive) will automatically create minds-off results. He concludes that learning can result when appropriate high level cognitive processing occurs in either high or low behavioral activity, and only with appropriate guidance or feedback. His work underscores the importance of strategically selecting instructional activities from along the generative/supplantive continuum based on Smith & Ragan's three factors of context, learner and learning task.

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Geotagging

SEE MOBILE DEVICES AND FUNCTIONS

Germane Cognitive Load

SEE COGNITIVE LOAD

Gigabit
SEE INFORMATION STORAGE

Globalized Instruction
SEE CULTURE-NEUTRAL DESIGN

Global Positioning System
SEE MOBILE DEVICES AND FUNCTIONS

Graphics
SEE ALSO AUDIOVISUAL INSTRUCTION and COMMUNICATION and DUAL CODING THEORY and SEMIOTICS and VISUAL AND PICTORIAL LEARNING and VISUAL COMPETENCY

According to Schlosser and Simonson (2006), the term “graphics” is simply defined as “two- or three-dimensional images, typically drawings or photographs” (p. 102). Pierce (1906) distinguished visual graphics from text in how they represent information; graphics are depictive and text is descriptive. A graphic in instructional design refers to a static pictorial, schematic, graph or chart and is often enhanced to direct the viewer’s attention to certain information or to relate one piece of information to another. From posters and job aids to illustrated children’s books, maps, and instructions for assembly, carefully constructed pictures intended to convey information are commonly used to facilitate learning.

Graphics have been known under other names. They are often called visual aids in the context of instructional design and are broadly recognized as useful (Levin, Anglin & Carney, 1987). Semiotic theory identifies a graphic as a type of sign called an icon (Driscoll, 2005).

The use of pictures in the design of instruction is intended to engage the cognitive process of encoding in the learner where new information is related to prior knowledge in a meaningful way. Paivio’s dual coding theory (Clark & Paivio, 1991; Paivio, 1986) holds that visual information is processed and encoded across both the verbal and imagery cognitive subsystems, leading to greater retention of information. Mayer’s (2001) model of multimedia learning also theorizes that different cognitive processing of depictive content along with descriptive (text) leads to mental models that the learner then resolves into a single mental model which results in greater comprehension.

Mayer (2001) proposes specific principals to guide the use of graphics in instructional materials to increase efficacy. These principals encourage the use of pictures and corresponding words in close proximity both temporally and spatially, a preference for audio narration over text, limiting extraneous and redundant information, and an awareness that design effects can impact learners differently. Schnotz (2002) notes that semantic processing is needed to comprehend the meaning of an image rather than merely perceiving the image itself. The use of graphics in combination with text or audio information is generally regarded as a powerful instructional method, provided all information is presented simultaneously, with clarity, that prior knowledge is activated and the learner has sufficient visual literacy.

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Griefing

SEE ON-LINE BEHAVIOR

Guided Discovery Learning

SEE DISCOVERY-EXPOSITORY LEARNING CONTINUUM

H

Hierarchical Sequencing

SEE SEQUENCING

Human Information Resources

SEE INFORMATION RESOURCES

Human Performance Improvement

SEE PERFORMANCE IMPROVEMENT

Human Performance Technology

SEE PERFORMANCE IMPROVEMENT

Hybrid Learning

SEE BLENDED LEARNING

I

Icon

SEE SEMIOTICS

Ill-Structured Problem

SEE PROBLEM

Imagery

SEE ANIMATION and COGNITIVE STRATEGIES

Indexing

SEE INFORMATION CLASSIFICATION

Individual Constructivism

SEE CONSTRUCTIVISM

Individual Ethics

SEE ETHICS

Individualized Instruction

SEE ALSO LEARNER-CENTERED INSTRUCTION and MASTERY LEARNING and OPEN EDUCATION and PROGRAMED INSTRUCTION and SELF-DIRECTED LEARNING

Educators have long recognized that learners differ in numerous ways and that instruction should be tailored to meet individual needs and interests. Various programs have been devised to provide individual learners with experiences adapted in terms of pacing, content, and instructional treatment; such programs typically monitor student progress and prescribe subsequent lessons based on achievement.

The concept of individualization was not prominent during the audiovisual era of the educational technology field when the focus was on presentations to large groups, in either face-to-face or remote settings. But it moved to center stage when the field embraced programed instruction, the whole point of which was to replace lectures with tutorial devices that could receive individual student input and give them appropriate responses. As digital technology facilitated remote delivery of audiovisual media to individual learners, education-at-a-distance blossomed. Currently, much of the research and development effort in educational technology is aimed at improving the quality of distance education, including its adaptability to individual differences.

As public education expanded in the nineteenth and twentieth centuries, becoming more group-based and standardized for the sake of efficiency, it became more depersonalized and less effective. There were some notable efforts to break away from this group mode. In 1912 Frederick Burk prepared self-instructional units permitting elementary students to move through subjects at their own pace, and a few years later Carleton Washburne's Winnetka Plan incorporated this idea in a whole school curriculum (Saettler, 1990). Nonetheless, whole-group teaching remained the norm.

Individualized instruction emerged as a major educational movement in the 1960s, chosen as the theme for the 1962 NSSE yearbook (Henry, 1962), arousing the attention of reformers and researchers. Among the first to implement this emerging idea was Congdon Park elementary school in Duluth in the fall of 1964 with a continuous progress program using individual lesson plans (Esbensen, 1968). Like all that followed, they struggled to find software to support varied instructional approaches—materials aimed at specific objectives, incorporating multiple media, and adaptable to multiple ability levels (Esbensen, 1968).

By the mid-1960s nonprofit R&D centers were testing complete individualized instruction curricula, including:

- Individually Prescribed Instruction (IPI), a full set of self-study materials featuring individual prescriptions, frequent monitoring of student performance, and test-based advancement (Scanlon, 1973).
- Program for Learning in Accordance with Needs (PLAN), a computer-managed system in which students, depending on their achievement levels, were assigned to independent study, small-group activities, or teacher-led activities (Bishop, 1971).
- Individually Guided Education (IGE), a comprehensive program for school restructuring, including not only individually oriented instructional programing but also team-teaching, close home-school relations, and continuing research and development (Klausmeier, 1975).
- Learning for Mastery, a program based on prespecified criteria and the expectation that given sufficient time all students can achieve the lesson objectives (Bloom, 1968; Block, Efthim & Burns, 1989).

On the higher education front, in 1965, inspired by B.F. Skinner's work in programed instruction, Keller developed a college course based on continuous student progress by means of independent study units. It also included live lectures and demonstrations and a tutor to grade and correct tests throughout the semester as ways of increasing human interaction, hence the name Personalized System of Instruction (Keller, 1974). It became widely adopted in American colleges and universities and was evaluated as being the most instructionally powerful innovation up to that time (Kulik, Kulik, & Cohen, 1979).

During the 1970s self-instructional approaches proliferated, adding learning centers and stations, learning packages, and performance-based modules. But by the end of the 1970s the national mood had shifted "back to basics" and funding for experimentation was drying up. Furthermore, there were questions about the worth of such programs; although they allowed self-pacing—usually working in isolation, they offered little in the way of varied content or treatment.

Today the focus of individualization has shifted toward "personalization" (Keefe & Jenkins, 2008), with an emphasis on the social dimension of learning. The earlier manifestations are now considered to be limited by their focus on the cognitive dimension, narrowly specified objectives, solitary study, and test-based assessment. Personalized instruction aims to provide a holistic learning environment featuring frequent and close personal associations among students and teachers, with emphasis on collaborative groups and authentic assessment. However, since distance education is the most common venue for individualized instruction nowadays, the ideal of collaborative learning becomes problematic in that there is often a tension between learners' desire for control over the timing of their study and the opportunity to engage in collaborative activities (Goodyear, 2008).

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Individually Guided Instruction

SEE INDIVIDUALIZED INSTRUCTION

Individually Prescribed Instruction

SEE INDIVIDUALIZED INSTRUCTION

Informatics

SEE INFORMATION GATEKEEPER

Information

SEE LEARNING WITH INFORMATION

Information Access

SEE ALSO INFORMATION RETRIEVAL and INFORMATION STORAGE

Chalmers (1999) discusses four approaches to information access. They are known as information retrieval, workflow, collaborative filtering and the path model. These approaches differ in terms of the notions of being relevant, timely, and recommended.

Information retrieval is concerned with access to documents and does not consider the people that may have accessed the documents in the past nor the context within the act of locating the documents (Chalmers, 1999, p. 1112). While weighting of term frequency multiplied by the inverse of the document frequency is a scheme that can occur to determine the relative weight of retrieval of a document, the argument to perform this calculation is weak. Metrics on the retrieval rate of documents would be large and prohibitive.

Workflow refers to the relevance of a document to a person's job performance. Documents would be presented to a worker in an organization at the time of need and in a manner most useful to the worker. It is the worker's role within the organization that is critical.

Collaborative filtering is a schema that depends on the retrieval patterns of a document by people with similar interests (Chalmers, 1999, p. 1115). We often see this strategy in use at Amazon.com. After searching for a book, we often find a pane of information of books found by other people that also found our original book.

The path model tracks the words and URL's of a user's search stream as a history of actions. As a user moves the mouse pointer over a computer screen, the path model system tracks the word nearest the cursor every second. The word nearest the cursor is thought to be important, especially if a person hovers or stops on a word. Obviously, issues of privacy are raised and thus, this tracking feature can be turned off. However, from a scholarly perspective it is intriguing to look at the words people consider important as they manipulate the text and images on a screen (Chalmers, 1999).

When access to information is limited or blocked, a lack of transparency or even tragedy could occur. Gerber (2009) describes the use of audio description of information to blind people as one vehicle of presenting information to them. When that information is needed in an emergency, time is critically important. Thus, access to information is important in time-sensitive situations.

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Information and Communications Technology
SEE ALSO INFORMATION-RICH ENVIRONMENTS and SOCIAL MEDIA

Information and Communications Technology is typically known as ICT. Sometimes, it is erroneously called "Information Communications Technology," without the "and." Likewise the word "communication" is most appropriately plural, not singular.

Information technology (IT) is best defined by the *Oxford English Dictionary* (2012) as "the branch of technology concerned with the dissemination, processing, and storage of information, especially by means of computers." "*Communications* technologies" broadens the meaning to include networking and communications devices. The use of the term ICT is still in flux and it may be essentially synonymous with IT.

ICT as defined above is not a term unique to the study of pedagogy. In fact, ICT most often does not include pedagogy, but rather belongs to the category of computer science. A more practical pedagogically focused definition sees the term ICT as consisting of two parts: information technologies and communications technologies. In its simplest iteration, information technologies are those technologies which contain, store and disseminate information (e.g., books, films, and databases). Communications technologies, on the other hand, contain no information, and are designed for relatively short-term communication (e.g., pens, blogs, social networks, and smartphones). A relatively recent subset of communications technologies is social media, characterized by a Web 2.0 base and featuring user-generated content. Of course, the information and communications functions tend to merge. For example, the ubiquitous smartphone can store books and documents (i.e., information), but it also can act as a transmitter and receiver, rather than a container of information, and as such becomes a communications device. These functionalities are somewhat akin to Harold Innis's (1964) notions of time-biased and space-biased media where information technologies tend to be more permanent, and are therefore biased over time. Communications technologies, on the other hand, are global, instant, and light, and therefore biased across space.

Finally, policy documents that call for the integration of ICTs into teaching and learning are most often using the term as a call for ICT literacy.

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Information Classification
SEE ALSO TAXONOMY

Classification systems are used to sort and organize knowledge in either a manual or machine environment. Classification theory differentiates between two major groups: specific items that belong to a larger group and specific items that do not belong to that group. A group is mutually exclusive in that members of that group occur only in one class which has no overlapping content but also jointly exhaustive in that each class in the system contains only those things that are appropriate to that class (nothing relevant is omitted and nothing irrelevant is included). Ranganathan (1965) suggested that classification work be divided into three planes: the idea plane (the conceptual basis for knowledge organization), the verbal plane (the words that are used to describe concepts in the organization), and the notational plane (the decisions about the coding that stands for concepts within the system). The notational plane facilitates the use of the classification system by the end user because it demonstrates the position of each class within the system and shows the relationship of one class to the other classes. At present, two professional organizations, The International Society of Knowledge Organization (ISKO) and the Special Interest Group for Classification Research (SIG/CR) of the American Society for Information Science and Technology (ASIS&T) deal with classification activities and provide information about issues associated with the classification of knowledge.

Libraries generally rely on one of three systems established in the nineteenth century for classifying documents (which is any container of information, whether book, Web page, or audio-visual material): the Dewey Decimal Classification (DDC) system; the Universal Decimal Classification (UDC) system; and the Library of Congress (LOC) system. The DDC system was first published by Melvil Dewey in 1876 (Dewey, 1876). The DDC represents a top down approach to human knowledge and uses a mnemonic system of pure notation. It structures knowledge by ten disciplines in a general to specific arrangement. Presently, the DDC is used in 138 countries, over 60 of which also use it to organize their national bibliographies. In the USA, the DDC is used primarily by public libraries and smaller academic institutions. Highly specialized libraries employ the UDC, which is based on the DDC and seeks to account for the ever increasing output of human knowledge (Broughton, 2010). Larger academic institutions have found the DDC too restrictive and employ the LOC classification system, which is developed by literary warrant. (Literary warrant permits new classes to be added as the need arises, as opposed to the DDC, which is static.) The LOC is an enumerative guide to actual documents and is not intended as an inclusive classification of knowledge. The main criticism of the LOC is that it is too culturally bound to the American context.

Wendell G. Johnson

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Also See Additional Resources for Further Information on this Subject

Information Entropy
SEE MATHEMATICAL MODEL OF COMMUNICATION

Information Gatekeeper

An information gatekeeper facilitates the transfer of information within an organization, usually by informal methods. Kurt Lewin (1947) is credited with coining the term "gatekeeper" (which he used to describe the family member who decides which foods show up on the dinner table). The concept was applied to informatics by Thomas Allen (1977), who found that within organizations, a small number of key people (whom he termed "gatekeepers") exist to whom others frequently turn for information. According to Allen, new information is brought into the organization through these gatekeepers, who either have the information in the first place or know where to obtain it. The gatekeepers decide which information enters the organization and which does not, and then disseminate the information outward to other members of the organization.

The (human) gatekeeper is not to be confused with the gateway, which is a portal providing access to Web-based information (including blogs, wikis, and podcasts) outside of the control of the gatekeeper. The production, uploading, and retrieval of such user-generated content dictates that the individual end user becomes a coproducer and co-disseminator of information along with the gatekeeper. The gatekeeper's function thus becomes one of peer reviewer, who tailors the content of the information flow to the interests of the organization (Shoemaker & Vos, 2009). In today's environment, the gatekeeper balances the human and technological aspects of information systems, exhibits a strong client orientation in the delivery of information resources and service, analyzes the organization's or individual's information needs and matches those with the resources at hand, and analyzes the structure, flow, and use of information with the organization (Carr, 2003).

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Information Literacy
SEE LITERACY

Information Object
SEE INFORMATION-RICH ENVIRONMENTS

Information Processing Theory
SEE ALSO CHUNKING and COGNITIVE LEARNING THEORY and INFORMATION THEORY and MEMORY

Information Processing Theory (IPT) may be construed as a descendant of Information Theory, which had developed various principles of information transmission, processing, and storage, based on statistics and probability. Information Theory had as its core concept the binary digit, or "bit," a construct that could only take on one of two values (0 or 1), and was very focused on statistical and probability theory. However, some of its ideas served as a more general metaphor for enterprises less concerned with engineering and abstract mathematical theorizing by broadening the meaning of "information" beyond the "bit."

In the 1950s, several individuals now identified as modern precursors of cognitive psychology began to research the role of attention and perception in processing stimuli in order to identify the contributions of the psychological processes in understanding experiences. These innovations include Donald Broadbent's (1971) filter theory, George Miller's (1956) magic number, and Colin Cherry's (1953) cocktail party phenomenon. Whereas Information Theory had concentrated on theoretical principles for information content and mechanical manifestations for them, Information Processing Theory addressed the human element in understanding events.

These efforts and others were based on the idea that processing capacity was to be understood not in terms of "bits," but instead what came to be called "chunks." A chunk is a psychological unit, being the integration of several smaller units into a larger understood unit. For example, the numerals 4, 0, 3, may be understood as three unrelated units, but if one recognizes them as the telephone area code for a particular region, the memory load is reduced from three to one chunk, freeing up processing capacity. Determining the number of chunks and how they are used to process information continues to be a topic of inquiry (e.g., Cowan, 2001).

The chunking reconceptualization of information played a key role in launching Information Processing Theory, a label now used to describe psychological research on learning, memory, and many other areas. It was somewhat inspired by Information Theory originally, but its general form is more conceptual than quantitative. Sometimes alternatively labeled as "cognitive psychology," this tradition does not rely upon formal mathematical development; instead it uses the computer as a metaphor for understanding human learning, memory, cognitive processes, decision making, language, intelligence, and development.

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Also See Additional Resources for Further Information on this Subject

Information Resources

SEE ALSO MEDIA

Information resources are media (print and digital) and people which have the potential to support learning (Hannafin & Hill, 2008). Examples of static information resources (those resources generated by the author and which cannot be changed by the end user) include print books and serials (journals and magazines), audio-visual material, electronics items (subscription databases and electronic books) and Internet-based Web pages. Dynamic resources (those in which the end user can change) include wikis, blogs, and podcasts.

The use of these socially constructed resources has raised the question of the credibility and authenticity of their content (McPherson, 2006). Since the dynamic resources may be unreliable, a human resource (whether it be a teacher or librarian) is called upon to serve as a peer reviewer and evaluate the information. Educational technology gives a special role to information resources in Resource-Based Learning (RBL) where students construct meaning through interaction with print, digital, and human resources. RBL is student centered and the teacher is viewed as a facilitator and guide. It is employed as a means of fostering information literacy and critical thinking skills among students.

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Information Retrieval

SEE ALSO INFORMATION ACCESS and INFORMATION STORAGE

Information retrieval (IR) is information-seeking behavior which uses computer technology to access desired information from a database. Information may be retrieved directly, through an interface, or indirectly, through an intermediary (e.g., a librarian). Retrieval is dependent upon searching within certain defined and indexed fields, such as title, author, subject, etc. The information must be represented in the query language of the database: if text-based, in the bibliographic descriptors; if digital, as metadata. IR is facilitated by the use of Boolean operators (AND, NOT, OR) to refine the relation of search terms. The AND relation combines two or more terms with a given data field to narrow the results of the search. The NOT relation is the inverse of the AND relation; only one of the terms appears in the data field and the other terms are excluded. The OR relation seeks separate results for each of the search terms and thus broadens the retrieved data pool. The end-user employs the Boolean operators to determine the relevance of the documents retrieved, which are listed in descending chronological order.

The various formats of recent information sources (video, images, speech) and the increased reliance on Web 2.0 applications in education present special challenges to information retrieval. IR is trending towards federated or integrated searching, which permits simultaneous access to multiple sources of information (databases and Web pages, for example), eliminating the need to search individual sources consecutively. The caveat to federated searching is that the information sources need to be catalogued or indexed before they can be retrieved. Educational technology recently has turned its attention to inquiry-based information retrieval, which consists of submitting questions to an online information repository (Graesser, Chipman & King, 2008). An information seeker can submit a query to Google, for example, using natural language. Google will not directly answer the question, but return documents and Web pages that contain answers to the query. Major search engines, such as Google, use best match IR, which measures recall (number of relevant articles retrieved ÷number of relevant documents in the database) and precision (number of relevant documents retrieved/number of documents retrieved) (Järvelin, 2003).

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Also See Additional Resources for Further Information on this Subject

Information-Rich Environments
SEE ALSO INFORMATION AND COMMUNICATIONS TECHNOLOGY and LEARNING WITH INFORMATION

"An information-rich environment is any venue — formal or informal, actual or virtual — which contains information objects in any format that could be used for learning" (Neuman, 2011, p. 18). Such environments include brick-and-mortar facilities, traditional broadcast media, and the full sweep of digital offerings. The information objects these environments house are the physical and virtual entities, from simple pie charts to complex simulations, through which they convey information. Viewing all such venues as "information-rich environments" invites learners to focus on the information each provides rather than on the containers the venue uses to convey the information. At the same time, thinking in terms of "information objects" invites learners to consider the specific ways in which a particular object enables and constrains the way its information is organized and presented.

The concepts of "information-rich environments" and "information objects" represent the fusion of several long-standing perspectives in two related fields: educational technology and information science. Salomon's (1979) work on media and cognition and Kozma's (1991) typology of media formats according to their "cognitively relevant characteristics" provide the underlying theory from educational technology, while Dervin (1998) and Kuhlthau (1993) treat theoretical issues related to learning from an information-science perspective. Multiple chapters in the second and third editions of the *Handbook for Research in Educational Communications and Technology* (2004, 2008) provide an exhaustive compendium of details related to the ways the design and presentation of various information objects enhance and constrain learning (e.g., Anglin, Vaez & Cunningham; Barron; Gredler; Hill, Wiley, Nelson & Han; McLellan; Rieber; and Seels, Fullerton, Berry & Horn in the 2004 *Handbook*; Cannon-Bowers & Bowers and Pfaffman in the 2008 edition). The information-science literature on information seeking and use provides insights into how students and others who use information resources are both aided and constrained in making meaning from the various ways those resources are organized and presented. (See "Learning with Information" for key works in the area).

As we move more deeply into the information age, opportunities for learning will continue to abound in the wealth of sophisticated technologies that spring up regularly. Thinking of these technologies in terms of their information content, organization, and attributes provides a way to bypass a focus on "bells and whistles" in order to concentrate on information—which is, in fact, the basic building block for human learning. As schools in particular depend more and more on commercial technologies as learning venues, Jonassen, Peck & Wilson's (1999) description of the five roles that information and communications technologies can play to support learning provide guidance for maximizing learning in these information-rich environments. According to these authors, learners can use the technologies as "tools to support knowledge construction … information vehicles for exploring knowledge to support learning-by-constructing … context to support learning by doing … a social medium to support learning by conversing [and] an intellectual partner to support learning-by-reflecting" (pp. 13–14).

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Information Storage

SEE ALSO INFORMATION ACCESS and INFORMATION RETRIEVAL

Educational information is stored in libraries, institutional repositories and archives. Libraries are collections of materials organized so that they may be easily identified and retrieved. Libraries are organized around a set of core functions: technical services (identification, acquisition, and classification of material), public services (reference services and bibliographic instruction), and management (planning, financial management, and human resources). Library media centers are "physical repositories of instructional materials and technology resources found in many American public schools" (Neuman, 2008, p. 234). Research has shown a very strong relationship between reading attainment and school library use (Scott & Piourde, 2007). Students who read above grade level are twice as likely to be users of their school library as are their peers who read below grade level. Certification as a school librarian or media center specialist is often obtained through a department of educational technology.

As more and more information is being created in digital formats, colleges and universities are establishing institutional repositories which allow open access to the institution's research and records. Open Archival Information Systems (or OAIS, an ISO standard since 2002), often serves as the reference model for institutional repositories. Repository architecture manages content as well as metadata and provides the option of depositing and retrieving information by means of controlled, hierarchical access. Institutional repositories provide a proprietary alternative to student assessment programs such as LiveText or course management systems such as Blackboard. Two of the main concerns regarding institutional repositories are copyright and intellectual property rights (Zuccala, Oppenheim & Dhiensa, 2008).

Archives are historical collections of primary source material in a variety of formats (e.g., printed or digital matter; audio-visual records). They preserve the historical record of an institution or individual(s) in the broadest sense. The Blackwell Museum on the Campus of Northern Illinois University, for example, archives the AECT collection of tools and documentation used by professionals in the field of educational technology during the nineteenth and twentieth centuries. During the digital age, professional archivists face the issue of preserving the physical artifact (e.g., the paper copy) while budgets are cut and space is at a premium (Bee, 2008).

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Information Theory

SEE ALSO CHUNKING and INFORMATION PROCESSING THEORY

Information Theory refers to a mathematical and statistical theory for quantifying information. The basic unit in information theory is the "bit," referring to the notion of a binary digit, a construct that can have only two values, 0 and 1 (or present, absent, or true, false, or open, closed, or other such dichotomies). Information Theory developed various principles of information transmission, processing, and storage, based on statistics and probability, including schemes for the compression and decompression of messages.

The immediate background for the discipline of information theory included research on signal detection and processing and code-breaking during World War II (e.g., Alan Turing's work), and cryptography remains an important area of application for Information Theory. In a practical sense, the two-valued "bit" construct had been used from the late 1800s with the early punched card technologies that launched the computer industry (e.g., Herman Hollerith's work, and earlier Charles Babbage's work); that use was updated in an early book by Vannevar Bush (1936). Claude Shannon, a student of Bush, is generally credited with launching what is now called Information Theory in a book that combined the various threads (Shannon, 1949). Following these developments, Information Theory not surprisingly stimulated the areas now known as cognitive science, artificial intelligence, robotics, and cybernetics.

Information Theory also permits extrapolation of some of its ideas to enterprises less concerned with engineering and abstract mathematical theorizing. In the 1950s, several individuals now identified as cognitive psychologists began to research the role of attention and perception in processing, including Donald Broadbent (1971), George Miller (1956), and Colin Cherry (1953). Their work was often based on the idea that processing capacity was to be understood not in terms of bits but instead what came to be called "chunks." A chunk is a psychological unit, being the integration of several smaller units into an understood unit.

The chunking reconceptualization formed the basis for Information Processing Theory, a label used to describe psychological research on learning and memory and cognition. It was somewhat inspired by Information Theory originally, but its general form is more conceptual than quantitative. This tradition does not adhere to formal mathematical development, using instead the computer as a metaphor for understanding cognitive processes and development.

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Also See Additional Resources for Further Information on this Subject

Innovation
SEE ALSO CHANGE and CHANGE MODELS

An innovation is a technological product or practice that is novel to a given population and that adds value to the user. The spread of innovations has been studied by anthropologists and sociologists since the late nineteenth century, but their findings did not come to attention in the education community until gathered and synthesized by Everett Rogers in *Diffusion of Innovations* (1962).

The term "innovation" did not appear in early glossaries of educational technology (Ely, 1963; Association for Educational Communications and Technology, 1977). Its relevance became more apparent as scholars expanded the framework of instructional design to include responsibility for implementing the instructional materials and systems that resulted from the design process. For example, beginning in the early 1970s the academic program at Indiana University was revamped to include an emphasis area of diffusion and adoption of innovations. And in 1980 the monthly periodical of AECT was renamed *Instructional Innovator* to reflect this new framing of the work of the field.

It is now commonplace to characterize the mission of the field as promoting the adoption of technological innovations and to use diffusion of innovation theory as a framework for studying this issue (Dooley, 1999; Dormant, 1986; Ely, 1999; Romiszowski, 2004).

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Inquiry-Based Learning

SEE ALSO LEARNER-CENTERED INSTRUCTION and PROBLEM-BASED LEARNING and PROJECT-BASED LEARNING

Inquiry-based learning is a dynamic process of coming to know and understand the world in genuine and authentic ways that take their cue from how knowledge actually lives and works in the world. It encompasses the processes of posing questions, problems or issues, gathering information, thinking creatively about possibilities, becoming proficient in providing evidence, making decisions, justifying conclusions, and learning the ways of challenging, building upon and improving knowledge of the topic or field of study. Inquiry or inquiry-based learning can encompass a range of practices including project-based learning, problem-based learning and design-based learning (Barron & Darling-Hammond, 2008).

Inquiry is not a general teaching method, but is always intimately linked to a particular topic or field of study and what that field or topic requires of those coming to know it. Opening up such topics or fields for exploration is the opening up of an inquiry space in which students, teachers and disciplinary experts can then collaboratively work on investigating the rigors and disciplines that shape and guide work in that field. The pedagogical act within inquiry involves cultivating the topic or field in which powerful, thought-provoking questions can and do arise and to which they can return, and providing students access to ways of being and knowing within the disciplines. "Without undertaking inquiry in this way, the questions cannot gain the heat they need to be both powerful and thought-provoking" (Clifford & Marinucci, 2008, p.678).

The teacher within an inquiry-based learning classroom is an active participant in and contributor to the inquiry. "The skills of classroom inquiry include careful observation and reasoned analysis, as well as dispositions toward an open and searching mind and a sense of responsibility and commitment to children's learning" (Darling-Hammond, 2006, p.5). It is a learning environment filled with diversity, for the teacher is fully aware and present to the knowledge that inquiry happens in ecological spaces where complex, hidden connections already exist or are created through the ways in which the topic is taken up by the students and teacher (Jardine, Clifford & Friesen, 2003, 2006; Jardine, Friesen & Clifford, 2008).

In classrooms engaged in genuine inquiry the topic is broad enough so everyone, teachers, students and experts in the discipline, can find a place to make meaningful contributions to the topic itself and to their own understanding of the topic. Inquiry classrooms are more studio-like in look and feel. Students are organized according to the demands of the work and all work in progress is always made public. Every student knows what every other student is doing. In addition to that, every student gets to witness the thinking processes of the other students. The teacher, in turn, attunes herself or himself to the ongoing work of the students (Clifford & Marinucci, 2008, p.684).

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Instant Messaging
SEE TECHNOLOGICAL COMMUNICATION

Institutional Ethics
SEE ETHICS

Institutional Repositories
SEE INFORMATION STORAGE

Instruction
SEE ALSO CONDITIONS OF LEARNING

Instruction is a widely used term with at least two meanings. In a first meaning "instruction" can be used as synonymous to directive or command. For instance in their study on therapist behavior, Iwata et al. (2000) consider attention and instruction, and in this case instruction is "defined as a verbal directive to perform a task, delivered either with or without a supplemental prompt" (p. 184).

In a broader sense of the word, instruction seems to refer to external activities designed to support learners in view of enhancing goal-directed learning processes. Over the years this has been worded with slight differences in emphasis. Gagné, Briggs, and Wager (1988) in the third edition of *Principles of Instructional Design* specify "Instruction, then, may be conceived as a deliberately arranged set of external events designed to support internal learning processes" (p. 11). The same message is conveyed by Driscoll (2005). She explains: "By instruction I mean any deliberate arrangement of events to facilitate a learner's acquisition of some goal" (p. 23). Smaldino, Lowther, and Russell (2008) alter the view of these external events a bit and reformulate the goal-directedness. They indicate that instruction "refers to any intentional effort to stimulate learning by the deliberate arrangement of experiences to help learners achieve a desirable change in capability. Instruction is meant to lead to learning" (p. 25). Discussing the relationship between construction and instruction Reigeluth and Carr-Chellman (2009) argue that any learning implies construction and hence instruction can only be effective when it fosters construction. As a consequence they define "instruction as anything that is done purposely to facilitate learning" (p. 6). In this description of instruction, the notion becomes very much like the notion of teaching which, for instance, is defined by Loewenberg Ball, and Forzani (2009) as "the deliberate activity of increasing the probability that students will develop robust skill in and knowledge of the subject under study and coordinated with larger educational aims" (p. 503).

While in general there seems to be some consensus about the overall meaning and function of "instruction," this consensus does not extend to the actual quality of that instruction, the nature of the goal-directedness or the actors that may provide the support. At the core of the discussion is the nature of learning goals and the amount and quality of learner control. In order to avoid a strong emphasis on the instructor which is argued to be embedded in the notion of "instruction" itself and to strengthen an emphasis on the learner, various authors have argued in favor of using the notion of "learning environment" rather than "instruction" (e.g., Wilson, 1995).

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Instructional Agent
SEE AGENT

Instructional Analysis
SEE ANALYSIS

Instructional Context
SEE CONTEXT

Instructional Design
SEE ALSO INSTRUCTIONAL DESIGN MODELS

Instructional design (ID) has been defined over the years in a variety of ways. These definitions tend to emphasize either process or function. However, all definitions portray ID as an instructional planning activity, one which is characterized "by the level of precision, care and expertise that is employed" (Smith & Ragan, 2005, p.6).

Examples of process-oriented definitions include Smith and Ragan's (2005) definition which describes ID as "the systematic and reflective process of translating principles of learning and instruction into plans for instructional materials, activities, information resources, and evaluation" (p. 4). This definition emphasizes ID's scientific foundations and the range of products emanating from ID projects. The vast majority of process-oriented definitions, however, are closely tied to the traditional instructional systems design (ISD) process (i.e., analysis, design, development, implementation, and evaluation). Dick, Carey & Carey (2009) simply say that instructional design is ISD. While others may not be as direct, in essence they are agreeing with this approach (see Morrison, Ross, Kalman & Kemp, 2011; Piskurich, 2006, Seels & Glasgow, 1998 for example).

Some ID definitions stress function more than process. Gustafson and Branch (2007) say that "Instructional design (ID) is a systematic process that is employed to develop education and training programs in a consistent and reliable fashion" (p. 11). Piskurich (2006) suggests fundamentally ID "is simply a process for helping you to create effective training in an efficient manner" (p. 1). Another function-oriented interpretation of ID is presented by Reigeluth (1983). He describes ID as "a body of knowledge that prescribes instructional actions to optimize desired outcomes, such as achievement and affect" (p. 5).

Richey, Klein & Tracey (2011) combine the process and function points-of-view in their definition which describes instructional design as "the science and art of creating detailed specifications for the development, evaluation and maintenance of situations which facilitate learning and performance" (p. 3). This definition is also compatible with the current emphasis on performance improvement and designer's frequent uses of noninstructional interventions.

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Instructional Design Models

SEE ALSO FEEDBACK and GAME DESIGN and INSTRUCTIONAL DESIGN and RAPID PROTOTYPING and SYSTEMS APPROACH

Instructional design (ID) models are simplified overviews of ID procedures. They are typically visual representations, such as process flowcharts, that prescribe the steps that should be followed in a design project. All models are "a representation of reality presented with a degree of structure and order" and they typically demonstrate an idealized view of the topic (Richey, Klein & Tracey, 2011, p. 9). Such is the case with ID models.

There are a wide variety of ID models, most of which describe an overall design project. They span and describe the development of instructional design itself. The first ID model has been attributed to the work of John Barson at Michigan State University in the 1960s (Gustafson & Branch, 1967). This model describes guidelines for higher education instructional design. However, the first widely distributed model was that of Dick and Cary (1978), a model which has evolved over time and is still in use today. These models were based upon what was then called the systems approach, and are referred to in general as ADDIE models. ADDIE (analysis, design, development, implementation and evaluation) summarizes the five key phases of systematic instructional design.

Today there are a variety of other models prominent in the ID literature. For example, there is the Morrison, Ross, Kalman, and Kemp (2011) model which is presented in a circular fashion to address the criticism that the ID models are too linear and may not reflect actual design practice. There are also motivation design models such as Keller's (2010) ARCS model. This model highlighting the role of attention, relevance, and confidence as a foundation for motivated behavior is incorporated into the traditional systematic approach to ID. Another current approach is known as the 4C-ID model (van Merriënboer & Kirschner, 2007). This ten-step model centers on the integration and coordination of skills that make up complex learning. It is directed towards authentic learning in either real or simulated environments and employs strategies that facilitate learners' cognitive learning strategies, schema construction and rule learning.

While people typically still think of ID models as reflecting an instructional systems design orientation, they can and do mirror a variety of approaches to the ID process. For example, Cennamo and Kalk (2005) present an ID model that stems from a constructivist orientation and also incorporates rapid prototyping processes. These processes entail the use of social negotiations and the design of instruction viewed from multiple perspectives.

Even though there have been some concerns expressed as to the value of ID models, they remain a fundamental part of the practice of instructional design. They "offer guidelines and can ensure a level of quality and uniformity" (Brown & Green, 2006, p. 9). Moreover, they serve as critical components of most programs which prepare instructional designers for the workplace.

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Instructional Development
SEE DEVELOPMENT

Instructional Media
SEE AUDIO-VISUAL INSTRUCTION and CONE OF EXPERIENCE

Instructional Objectives
SEE ALSO COMPLEX LEARNING and CRITERION-REFERENCED MEASUREMENT and EVALUATION MODELS

Instructional objectives are “statements that describe what students will do after completing a prescribed unit of instruction” (Kibler, Cegala, Barker & Miles, 1974, p. 2). They have been also called “behavioral objectives,” “performance objectives,” “learning objectives” or simply “objectives.” Regardless of the name used they were traditionally cast as observable and measureable behaviors with at least three component parts—the behavior, the conditions under which the behavior is demonstrated, and the criteria by which the behavior is judged (Mager, 1962). Objectives can be written for all types of instruction and all types of content. Objectives serve a variety of purposes. The original emphasis was to communicate to learners the goals of instruction—what you are going to be able to do after instruction, and to serve as the basis for the construction of test items and student evaluation. However, objectives also serve as a critical tool for the designer. They facilitate the selection and sequencing of teaching/learning activities and the selection and organization of instructional resources (Morrison, Ross, Kalman & Kemp, 2011).

Today many associate the use of instructional objectives with behaviorism and the systems approach to instructional design. However, they were introduced far before these positions were introduced. John Franklin Bobbitt (1918) first advocated writing objectives in the early part of the twentieth century as a part of his scientific approach to curriculum development. Tyler (1949) also outlined a curriculum development technique based upon specifying objectives, selecting and organizing strategies to attain the objectives and then evaluating whether they had been achieved.

The use of instructional objectives is still incorporated into the vast majority of current instructional design models (see for example Dick, Carey & Carey, 2009; Morrison, Ross, Kalman & Kemp, 2011; Smith & Ragan, 2005). However, those advocating a more constructivist approach to instruction and instructional design often employ a more collaborative and flexible approach to devising the objectives with both community members and students participating in the process (Cennamo & Kalk, 2005).

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Instructional Systems Design

SEE INSTRUCTIONAL DESIGN AND INSTRUCTIONAL DESIGN MODELS

Instructional Technology

SEE EDUCATIONAL TECHNOLOGY

Instructional Television

SEE TECHNOLOGY-ENABLED LEARNING

Instructor-Centered Instruction

SEE GENERATIVE AND SUPPLANTIVE INSTRUCTIONAL STRATEGIES

Integrated Technologies

SEE ALSO MULTIMEDIA LEARNING

In *Instructional Technology: Definition and Domains of the Field*, instructional technologies in the development domain are organized into the following four categories: print technologies, audiovisual technologies, computer-based technologies, and integrated technologies (Seels & Richey, 1994). Based on principles of cognitive science and constructivism, integrated technologies present information which is relevant to realistic learning in nonsequential or linear traditions according to the learner's desire, in order to facilitate cognitive-centered, meaningful learning through frequent interactions among learners, materials and technologies in an integrated environment.

Through integrated technologies, content can be presented very realistically in the context of the learner's experiences. Based on the high degree of learner interactivity (Seels & Richey, 1994) and the flexible presentation styles of learning materials to suit needs in the best way, integrated technologies are more attractive than traditional instructional technologies.

Tomei (2007) argues that, the prime functions of integrated technologies are to promote meaningful learning, to engage learners in the construction of new knowledge and the expansion of personal understanding, and to enhance professional productivity in educational organizations. Carver, Lehrer, Connell & Ericksen (1992) propose that from the perspective of constructivism the role of integrated technologies is converging on the value of students actively designing knowledge, particularly in the context of designing media presentations for real audiences.

Integrated technologies are often used by many institutions to build multimedia environments for learning (Elmore, 1992), particularly for teacher education programs such as Preparing Tomorrow's Teachers to Use Technology, commonly known as PT3 (Rhine & Bailey, 2005). In the 1990s, compact discs, DVD's, computer conferencing systems, robust authoring systems, and learning management systems were widely used as integrated technologies in teaching and learning practice. Recently, the most popular emerging integrated technology system is Web 2.0. This system uses the Internet as a platform for services and applications including Web-based materials, social networking, virtual learning environments (such as Second Life), and immediate communication tools (such as Skype).

Since integrated technologies incorporate diverse forms of media under the control of a computer to produce and deliver materials in a variety of ways for teaching and learning, they are essential for multimedia learning. This concept proposed by American educational psychologist Richard Mayer in the 1990s, assumes that optimal learning occurs when visual and verbal materials are presented together simultaneously (Mayer, 2001).

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Integrated Learning Systems
SEE ALSO COMPUTER-BASED TRAINING and MANAGEMENT SYSTEMS

Experts on this topic agree that an integrated learning system (ILS) is a computer-based blend of courseware and learning management software, housed on a computer network (Becker & Hativa, 1994; Brown, 1997; Brush, 1998). The courseware segment of the system delivers instructional content, remediation and enrichment; the learning management system monitors activity, records progress, and manages/informs next steps in the process.

While ILS curriculum content varies with each implementation, it commonly covers multiple grade levels within subjects such as reading, language, mathematics, science, computer skills and social studies (Mills, 1994; Kulik, 2003). Delivery of the ILS courseware content is computer-based, primarily utilizing drill-and-practice or tutorial approaches that are built on a foundation of behaviorist learning theory (Becker & Hativa, 1994; Wood, Underwood & Avis, 1999). Instructional strategies commonly include guided feedback and practice (Wood et al., 1999), and repetition and rehearsal of content (O'Byrne, Securro, Jones, & Cadle, 2006). More sophisticated systems offer simulation (Kulik, 2003), multiple completion paths, and some opportunities for problem solving and decision-making (O'Byrne et al., 2006). Online (and offline) supplementary material such as workbooks, manipulatives, third-party courseware, and "tool" software (word processing, database packages, etc.) are often available via the ILS (Brush, 1998; Mills, 1994). Student assessment within the ILS is also computer-based, and measures achievement against set criteria that can be evaluated by a computer (O'Byrne et al., 2006). The "traditional" nature of the assessment tends to limit the model used to characterize learner knowledge. This is "reflected in the restricted range of learning goals and pathways the ILS can support" (Wood et al., p. 103).

As described by Mills (1994), the typical ILS process begins with diagnostic assessments to place each student at an appropriate level within the available units or modules of courseware. As students move at their own pace through the instructional content on the ILS, the management system keeps records of his/her activity, choices and progress. Formative assessment is ongoing, allowing the teacher, the student and/or the ILS to monitor progress (Becker & Hativa, 1994). Feedback is immediate; remediation strategies and enrichment materials can be built into the system (Brush, 1998). Locus of control is shared between the teacher, the student and the ILS management segment. For example, based on assessment results, the teacher and/or the learning management system can manipulate content difficulty, sequence, and number of repetitions. In many systems, students can retry until mastery is reached and they can control the amount and kinds of help they want. Exercises with different examples can be generated to enhance practice (O'Byrne et al., 2006).

Although the design of integrated learning systems is based on the theory that learning is "best facilitated by meeting the needs of each individual learner" (Brush, 1998, p. 5), a number of researchers have argued the need for ILS design and implementation to support more social construction of knowledge (Becker, 1992, Brush, 1998, Wood et al., 1999). Only a few researchers have taken up the challenge (Kulik, 2003, Mevarech, 1994).

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Integrative Goals
SEE COMPLEX LEARNING and LEARNING TYPES

Integrative Objectives
SEE COMPLEX LEARNING

Intellectual Property

Simply put, intellectual property can be defined as "…a cluster of assets protected by federal or state law, including copyrights, patents, trademarks, and trade secrets" (Lipinski, 2006, p. xxx). Some scholars of intellectual property also include such things as rights of publicity and privacy, geographical indications, and industrial and integrated circuit designs (Goldstein & Hugenholtz, 2010; Hirtle, Hudson, & Kenyon, 2009) in the definition; however, such additions are infrequent and more often included when considering international intellectual property law.

The U.S. Constitution (1787) states in part that "Congress shall have the power… to promote the progress of science and useful arts, by securing for limited times to authors and inventors the exclusive rights to their respective writings and discoveries" (Art. 1, Sec. 8). This statement informs us that authors, inventors, designers, and initiators of works have the right—at least for a time—of owning that which they create. This part of the constitution "… is the basis of intellectual property rights in our country today and continues to be modified as necessary" (Butler, 2011, p. 8). Next, the four most common types of intellectual property (copyright, patents, trademarks, and trade secrets) are defined.

Copyright is one of the most common and important of intellectual properties for educational technologists who may find themselves on either side of the copyright aisle—either as the user or the creator/owner of a particular work. According to the U.S. Code (2010), copyright law safeguards for the owner/creator, "original works of authorship fixed in any tangible medium of expression" (p. 102). Works that can be copyright-protected include articles and books, sheet music, audio recordings, computer software, games, photographs, videos, blogs, e-mails, podcasts, and more (Butler, 2011).

A patent, assigned to a new/original invention, is a "…grant of a property right to the inventor, issued by the United States Patent and Trademark Office…" This right excludes "…others from making, using, offering for sale, selling or importing the invention" (Lamoureux, Baron, & Stewart, 2009, p. 94–95) and typically lasts 20 years (Lamoureux, et al.). In educational technology, patents examples include the invention of a new type of printer and computer software.

"A trademark is a word, slogan, design, symbol, or a color, smell, product configuration, or combination of these used to identify the source of origin of particular goods and services and to distinguish these from the goods and services of others." (Sherry, 2008, p. 78) The apple symbol (for software and computers, e.g., Apple Corporation) and Internet domain names, such as yahoo.com, are examples of trademarks.

Trade Secrets are types of information that give a work's owner a competitive, strategic advantage and can include "…a formula, pattern, compilation, program, device, method, technique or process" (Uniform Trade Secrets Act, 1985, p. 1). How a piece of software is encrypted might be a trade secret.

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Intellectual Skills

SEE LEARNING TYPES

Intelligent Tutoring Systems

SEE EXPERT SYSTEMS

Interaction

SEE ALSO COMMUNICATION THEORY AND MODELS
and DISTANCE EDUCATION AND LEARNING
and DISTRIBUTED COGNITION

Battalio (2007) notes there is no single, agreed upon definition for interaction used consistently in the literature. He adds that the common practice is to focus on the entities that interact, specifically the learner and the instructor, rather than the term. Wanstreet (2006) identifies the types of interaction that occur between these entities as learner-instructor interaction, learner-content interaction and learner-learner interaction.

Nuriddin (2011) defines instructional interactions as "reciprocal events between the learner and the learner's environment that mutually influence one another" (p. 32). This definition introduces the environment as a third interacting entity, in addition to the student and the instructor. This point of view leads to the recognition of a fourth type of interaction, that of learner-interface (Wanstreet, 2006).

Another frequently used approach to defining interaction is to consider it within the context of the type of communication and collaboration it fosters. Synchronous interaction refers to interactions that occur in real-time, with learners and instructors present simultaneously, either in person or linked through the use of various communication technologies. Asynchronous interaction refers to interaction that is not limited by time constraints. In the asynchronous environment learners and instructors use technology to participate at their convenience, creating time lags between when information is sent, received and responded to (Simonson, Smaldino, Albright & Zvacek, 2009).

Simonson et al. (2009) note that interaction is "needed and should be available" in distance education, but it "is not the 'end all and be all' of learning" (p. 82). They add that "forced interaction can be as strong a detriment to effective learning as is its absence" (p. 82). Nuriddin (2011) supports this position, stating that "interactions must be deliberately designed to facilitate the construction of knowledge through the collaboration process" (p. 33).

Wanstreet (2006) notes that while there is no a single agreed upon definition of interaction, there is in fact a "great deal of agreement on the conceptual definitions of the term" (p. 405). Interaction is communication between the learner and the instructor, the content, the instructional interface and other learners, designed to facilitate learning in both synchronous and asynchronous settings.

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Internal Conditions of Learning
SEE CONDITIONS OF LEARNING

Intrinsic Cognitive Load
SEE COGNITIVE LOAD

Intrinsic Motivation
SEE MOTIVATION

J

Job Aid

SEE ALSO ELECTRONIC PERFORMANCE SUPPORT SYSTEM and JUST-IN-TIME LEARNING

A job aid is a "tool to enhance performance" (Tilaro & Rossett, 1993, p. 13). It is an external source of information or guidance about how to complete a specific task immediately or how to plan for the execution of a task. (Rossett & Schaffer, 2007). Job aids, tools external to the individual, support three work and activity functions: to provide information, to support procedures, and to guide decision-making (Rossett & Gautier-Downes, 1991). At least one definition proscribes a job aid as helping employees before or while they are doing a job whereas a *performance* aid is dedicated to real-time, on-the-job help (Rothwell, 1996).

A job aid may be the preferred effective noninstructional intervention if the task meets certain requirements. Job aids may be preferable to training if the task is complex, it is performed infrequently, if errors are costly, or training is not feasible for the learners. Job aids have been an effective instructional strategy and can be especially effective when mistakes are costly, when the performance is complex, and variable (Spaulding & Dwyer, 2001). Job aids remain popular because they facilitate the convergence of work, learning, and information; are relatively simple to implement; and incorporate a performance-relevant design (Rossett & Schaffer, 2007).

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Also See Additional Resources for Further Information on this Subject

Job Analysis
SEE ANALYSIS

Just-in-time Learning
SEE ALSO JOB AID

Just-in-time learning is often nonsequential in nature and differs from traditional sequential learning. Rather than a traditional warehouse-type model of learning a set of skills and abilities to be used at a future point in time, just-in-time learning provides learners with necessary information at the time of need. Lave and Wenger (1991) suggest that effective learning occurs when it is embedded in activity, context, and practice. In this type of environment the learning is situated in a given point in time and may even be unintentional. The authentic need for such learning based on the given situation occurs through a process referred to as legitimate peripheral participation (Lave & Wenger, 1991).

Communities of practice provide the opportunity for interaction and collaboration with learners with similar needs or interests (Lave & Wenger, 1991). While job aids and performance support provide for just-in-time learning when individuals for potential collaboration are not present, the recent trend in the use of social networking tools and services in education and training environments provides a means of exposing learners to online communities of practice. Educators teaching in traditional classrooms or through learning management systems may still teach in a traditional sequential approach; however, they may also provide just-in-time learning in these same environments.

Blogs and wikis have been used for pre-class activities to create situations for just-in-time learning to occur within a classroom environment. The framework described by Higdon and Topaz (2009) encourages students to share, in their blog posts, any difficulties they are experiencing with the content to be learned and how the content is useful or relevant. This information is shared and aggregated in a course wiki, then used as a basis for the next course session. Specific problems with student learning are addressed within this framework through just-in-time learning.

Ostashewski, Moisey, and Reid (2011) describe three benefits of an online social networking framework as a delivery platform for professional development. These include: (a) control over the access and participation in the professional development activities, (b) development of peer relationships, and (c) experiential learning opportunities using the technologies that provide for communication within the social network. Teachers are able to extend the learning experience beyond the one-time workshop to the authentic real-time environment where the learning is applied. The design of this framework provides the support and infrastructure for just-in-time learning.

The learner-in-control approach will provide learners with required learning at the time of need (Adams & Morgan, 2007). Brill and Park (2011) describe a second-generation e-learning resource based on a study of online faculty tutorials. While the content is available anytime/anywhere, this second layer would provide for more collaboration and flexibility. Based on this type of approach "the user community may play a more prominent role in knowledge generation, capture, and sharing, [and] sociability may be a new dimension to consider in future e-learning" (Brill & Park, 2011, p.440).

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K

Knowledge Management
SEE ALSO EXPERT SYSTEM and LEARNING ORGANIZATION and MANAGEMENT SYSTEMS

A relatively new field, knowledge management (KM) began to coalesce in the 1990s as a result of advances in cognitive science and the understanding of human learning and metacognition (see Ausubel, 1963; Polanyi, 1967; Novak & Gowin, 2002), as well as interest from the business management field due to increased global competition (Argyris, 1991). As a consequence of these developments, organizations recognized the importance of intellectual capital and began to place more value on human assets than physical assets as primary drivers of business innovation and competitive advantage (Werner & DeSimone, 2012).

Most current definitions of KM reflect a process/outcomes view. KM is the set of activities and processes to collect, develop, share, and apply knowledge within an organization to gain and sustain a competitive advantage (Mihalca, Uta, Andreescu, & Intorsureanu, 2008; Petersen & Poulfelt, 2002). KM has received much attention in organizations, due in part to its seeming to be a solution to an aging workforce and a much feared "brain drain" (Hoffman, Ziebell, Fiore, & Becerra-Fernandez, 2008).

KM draws from several foundations. Expert-systems offer KM a practical set of knowledge elicitation tactics as well as a framework to create knowledge bases (Hoffman et al., 2008). Organizational theory brings to KM a systems view, respect for social factors, and the study of organizational culture (Firestone, 2008). Cognitive science offers information processing, cybernetics, and organizational learning (Despres & Chauvel, 1999).

Knowledge is often differentiated from data and information. Data represent discreet facts that have generally been measured in some way. Information is data that has been given a certain level of meaning by applying a context to it. Knowledge is yet a higher level where information has been processed by experience, communication, and inference (Zack, 1999).

A primary challenge of KM is the management of tacit knowledge versus explicit knowledge. Tacit knowledge is subconscious and hard to articulate, whereas explicit knowledge is conscious and can be precisely and formally articulated (Mihalca et al., 2008). A common way to describe different types of explicit knowledge are as declarative (e.g., concepts or descriptions), procedural (e.g., how something is performed), or causal (e.g., why something occurs). The management of tacit knowledge, in particular its acquisition, has been a challenge in KM.

There are many approaches to KM. According to Firestone (2008), the most common is the ecological approach, which is socially driven and based on an ecology where the individual exists in a social Web of groups, teams, and the larger organization. Knowledge is ultimately created and consumed at the individual level, and is supported by information technology. A criticism of the ecological approach is that it relies on individual motivation to seek out and acquire knowledge as needed, requires sustained communication and marketing efforts, and is rarely tied to business measures. Alternative approaches are decision-making approaches such as the Decision Execution Cycle Interruption (Firestone, 2008), technocrat/economic/behavioral "Schools" approach (Earl, 2001), and the personalization versus codification approach (Hansen, Nohria & Tierney, 1999).

In practice, the growth of knowledge management as a field has contributed to new job titles such as knowledge broker, knowledge engineer, and chief knowledge officer. KM has also contributed to the growth of practical methodologies such as communities of practice, concept mapping, and knowledge acquisition. The educational use of KM has been on the rise since 2005 (Uzunboylu, Eriş, & Ozcinar, 2011), an example of which is the implementation of KM as a support mechanism for teachers to supply them with both instructional tools and feedback mechanisms (Bain & Swan, 2011).

KM still faces many issues, primary of which is a lack of consensus about a definition, which ultimately affects the credence of claims of KM's successes or failures (Firestone, 2008). Additionally, there has been confusion in the boundaries between KM and Information Management (Vasconcelos, 2008). KM has seen mixed results since its inception and use in organizations, which may be a result of its immaturity as a field, the inconsistent use of various methodologies, as well as the lack of agreement between academics and practitioners as to what really is KM.

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Also See Additional Resources for Further Information on this Subject

Knowledge Object

SEE LEARNING OBJECT

L

Lean Media
SEE RICH MEDIA

Learner Analysis
SEE ANALYSIS

Learner-Centered Instruction
SEE ALSO COLLABORATIVE LEARNING and CONSTRUCTIVISM and DIFFERENTIATED INSTRUCTION and GENERATIVE AND SUPPLANTIVE INSTRUCTIONAL STRATEGIES and INDIVIDUAIZED INSTRUCTION and OPEN EDUCATION and PROBLEM-BASED LEARNING and PROJECT-BASED LEARNING and SELF-DIRECTED LEARNING

The term, "learner-centered" refers to an instructional paradigm rather than to a single instructional method. It lies in contrast to the teacher-centered paradigm of instruction. It was defined by McCombs and Whisler (1997) as "the perspective that couples a focus on individual learners and a focus on learning" (p. 9). The learner-centered paradigm is based on constructivism (Hannafin & Land, 1997) which proposes that knowledge is individually constructed by learners (Driscoll, 2005), often through social negotiation (Littleton & Hiikkinen, 1999; Palincsar, 1998; Vygotsky, 1978), and is easier to acquire when contextually situated (Brown, Collins, & Duguid, 1989). In learner-centered instruction, learners are allowed and encouraged to construct their own knowledge by actively participating in the learning process, instead of teachers delivering knowledge and students passively listening.

The American Psychological Association Presidential Task Force on Psychology in Education (1993) identified fourteen learner-centered psychological principles that concern cognitive/meta-cognitive, motivational/affective, developmental/social, and individual-differences factors. The most central principle of the learner-centered paradigm is the shifted control of learning from teachers to learners. Traditionally, the teacher has been responsible for selecting instructional objectives, content, and instructional strategies. However, in the learner-centered paradigm, the learners take more control of their own learning and more responsibility for choosing what to learn and how to learn (Reigeluth & Moore, 1999). This emphasis on individual learners is also highlighted by Bransford, Brown, and Cocking (2000) who describe the importance of customizing instruction to individual learners and helping learners take control of their own learning.

Instructional methods that comply with these learner-centered principles include, but are not limited to, inquiry-based learning, problem-based learning, project-based learning, collaborative learning, cooperative learning, authentic learning, active learning, self-directed learning, personalized learning, individualized learning, and differentiated instruction. Reigeluth (1999) summarized instructional design theories that fit the learner-centered paradigm.

Recently, research on the learner-centered paradigm has been focused on the role of technology in facilitating learner-centered instruction. Several renowned scholars in educational technology have highlighted the importance of technology in learner-centered instruction (Bransford et al., 2000; Hannafin & Land, 1997; Jonassen, 2008; Reigeluth et al., 2008), and numerous attempts have been made to create technology-enabled learner-centered environments.

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Learner Characteristics and Traits

SEE ALSO ANALYSIS and MOTIVATION and PREREQUISITE SKILLS

Learner analysis is the process of collecting and analyzing data targeted at identifying the characteristics and traits of the learner population prior to the design of instruction. Learner analysis informs the design process, allowing the instructional designer to select instructional methods, strategies and activities tailored to the intended audience's abilities and preferences. Morrison, Ross, Kalman and Kemp (2011) note "countless traits differentiate learners" (p. 57). The key to effective learner analysis is to focus analysis on the characteristics and traits that are most critical for the learning situation, keeping in mind that some information may be of interest but inaccessible based on a variety of constraints.

Learner characteristics have been categorized in many ways. Heinich, Molenda, Russell and Smaldino (1999) suggested three broad categories: general characteristics, specific entry characteristics and learning styles. Morrison, et al. (2011) recommend adding five additional categories to this list: "academic information, personal and social characteristics, culturally diverse learners, learners with disabilities, and adult learners" (p. 57). Dick, Carey and Carey (2009) discuss learner characteristics using eight categories. The first six align with the categorization strategies of Heinich, et al. and Morrison, et al. and include entry skills, prior knowledge, attitudes towards the content and intended delivery medium, academic motivation, education and ability levels and general learning preferences. They also include two unique categories, "attitudes towards the organization giving the instruction and group characteristics" (Dick, Carey & Carey, 2009, p. 93). For the purposes of this discussion, learner characteristics and traits will be organized according to the three categories presented by Heinich, et al. (1999). Other identified characteristics will be addressed as sub-categories of these three.

General characteristics are often referred to as demographics. They include factors such as age, gender, work experience, education and ethnicity (Morrison et al., 2011). Cultural diversity, personal and social characteristics, and physical and learning disabilities can also be considered general characteristics.

Entry characteristics are the "prerequisite skills and attitudes that learners must possess" prior to the start of instruction (Morrison et al., 2011, p. 58). Determining what the learner already knows about the topic allows the designer to insure that the instruction is not too advanced or too elementary for the audience. Entry characteristics also include technology skills. Prerequisite skills that must be considered in regards to technology, particularly as it relates to online learning, include both technical skills and self-directed learning capabilities. If learners are lacking in either of these areas they should be provided with remediation prior to the start of the course (del Valle & Duffy, 2007).

Learning styles refer to the learners' preferred or ideal learning modality. Sampson, Karagiannidis and Kinshuk (2002) note that "one of the major distinctions made in learning styles research is the visual/auditory/kinesthetic distinction" (p. 27). Another common method of categorizing learning styles is through the identification of individual strengths and weaknesses based on measures such as the Myers-Briggs Type Indicator, the Multiple Intelligences Inventory, and the Felder and Silberman Index of Learning Styles (Sampson et al., 2002). Each of these measures categorizes learners based on preferences; however, it is important to note that barring physical or learning disabilities, while learning may be more efficient when the instruction is aligned with the learner's preferred style, all learners can learn in all manners.

Identification of learner characteristics and traits facilitates the design of effective, efficient, learner-focused instruction. The challenge is to determine which characteristics are relevant, what data are available and how the output of the learner analysis can be used to inform the design process for both homogeneous and heterogeneous learner populations.

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Learning
SEE ALSO COGNITIVE PROCESSES and CONSTRUCTIVISM and LEARNING WITH INFORMATION and SITUATED COGNITION

Learning is a concept so foundational to the educational technology literature that it is sometimes presupposed. Instead, learning theory is discussed, because “The primary purpose of instructional design (ID) is to facilitate learning and improve performance. Therefore, theories which explain learning are extremely relevant to designers and the field’s knowledge base” (Richey, Klein & Tracey, 2011, p. 51).

As an example, Morrison and his colleagues (Morrison, Ross, Kalman & Kemp, 2011) focused on learning theory to make the point that such theories can help designers be more consistent in selecting instructional strategies that are likely to work in a given situation. Learning theories provide a research-based explanation for how people learn (Mayer, 2009), and their application enhances the probability for learning to be efficient and effective. But Morrison, et al. (2011) never defined learning itself. One is left to induce the meaning of learning from the process of instructional design and the types of problems to which it is applied.

Similarly, Spector (2008) remarked on the evolution of the psychology of learning, commenting that researchers and developers have changed how they think about instruction as our understanding of human behavior, cognition, and emotion has changed. Although learning theories have evolved over time, definitions of learning have remained relatively constant, and they focus on two aspects: *what* learning is and *how* learning occurs.

“What learning is” refers to the outcomes of learning. Learning is “acquiring knowledge and skills” (Donovan & Bransford, 2005, p. 1). Learning is “a change in a learner’s dispositions and capabilities” (Gagné as cited by Gagné, Wager, Golas, & Keller, 2005, p.3). Learning is “a persisting change in human performance or performance potential” (Driscoll, 2005, p. 9). Learning is “a change in knowledge” (Mayer, 2009, p. 59). These definitions all point to the fact that learners are in some way different after learning than they were before in what they know and can do. They may also feel differently as well, as Gagné (1985) acknowledged with the inclusion of dispositions, or attitudes, as a distinct category of learning outcome.

“How learning occurs” refers to the processes that bring about the change in the learner. Here again there is consensus that learning comes about through a learner’s experience, whether in an intentionally designed learning environment (Mayer, 2009) or simply through interactions with the world (Driscoll, 2005; Donovan & Bransford, 2005). “Learning requires experience, but just what experiences are essential and how these experiences are presumed to bring about learning constitute the focus of every learning theory” (Driscoll, 2005, p. 9). Despite the differing perspectives inherent in learning theories that instructional designers use to guide their work, there is broad consensus on three fundamental principles. What learners already know is important and must be engaged in new learning. Factual knowledge and conceptual frameworks are essential to develop competence, and self-monitoring of learning progress is important (Donovan & Bransford, 2005).

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Learning by Doing

SEE ALSO PROBLEM-BASED INSTRUCTION and PROJECT-BASED INSTRUCTION and SELF-DIRECTED LEARNING

The learning by doing approach has gained attention due to rising interest in performance-based instruction (Schank, Berman, & MacPherson, 1999) and the popularity of constructivist approaches to learning. The case-based reasoning theory provides the theoretical base for learning by doing (Schank et al., 1999). The theory hypothesizes that people learn by reasoning from their experiences through the process of "goals, plans, expectations, expectation failures, and explanations of failure" (p. 170). They index and store those experiences in "libraries" of memory, and when a situation requires them to perform a new task, they retrieve a similar case that can be applied to performing the task (Schank et al., 1999). The context, goal, and lessons learned from the experience become cues to retrieve a relevant memory (Schank, 1982). Therefore, instruction should provide an opportunity to create a relevant and sensible experience in practicing target skills.

Several instructional methods have been devised that foster learning by doing such, as project-based learning (Blumenfeld et al., 1991), problem-based learning (Norman & Schmidt, 1992), action learning (Revans, 2011), goal-based scenarios (Schank et al., 1999), and more. Among them, we describe two instructional methods: case-based instruction and theme-based instruction.

Case-based instruction (Merseth, 1991; Williams, 1992) or case methods (Patterson, 1951) engage learners in an analysis and discussion of a case that provides a relevant context and meaningful problems (Merseth, 1991; Williams, 1992). According to Merseth (1991), the purpose of the case method is “to generalize particular decisions into broader understandings of the principles” (p. 243). Therefore, case-based instruction is suited when the learner is in need of forming exemplary conceptual understanding of relationships that may be abstract (Savery, 2009).

Cased-based instruction was devised in law school by Christopher Langdell, who became dean of Harvard Law School in 1870 (Patterson, 1951), and it widely spread in legal and business education due to its benefits for teaching thinking skills and knowledge required of lawyers and businessmen (Patterson, 1951). Recently, case-based instruction has been gaining in popularity in teacher education (Andrews, 2002; McNaughton, Hall, & Maccini, 2001).

A well-structured case should include specific goals, plans, and expected outcomes (Schank et al., 1999). Unlike problem-based learning, case-based instruction guides the learner to arrive at a predetermined conclusion rather than open-ended, multiple conclusions (Savery, 2009), and the teacher is supposed to guide the learner to the conclusion. In the quest, the learners explain their thought process and rationale for their decisions.

Theme-based instruction (Beatty, 2009) or integrated thematic instruction (Kovalik & Olsen, 1997) prepares students to perform tasks through inquiries (Kovalik & McGeehan, 1999). Beatty (2009) defines theme-based instruction as “an approach to facilitating learning which brings together various domains of learning in order to support a unifying theme” (p. 278). The essence of theme-based instruction is that curriculum is integrated into a unifying theme. The theme serves to provide real-world contexts for learning, motivate and interest learners, and help learners to create interrelationships among sub components and topics within the theme (Beatty, 2009).

Theme-based instruction can span across domains, and is often implemented on a school level. After selecting a yearlong theme, curriculum and instruction are organized around the theme. For example, a school selects a theme, such as power, at the beginning of a school year. Then, teachers in subject areas, such as math, science, or social studies, select topics and focus on areas that are related to the theme, power. Science teachers can select a topic of electricity, and social studies teachers can choose a topic of how people create and change structures of power, authority, and governance. Cross-disciplinary instruction can be created as well. For example, using an election as a topic under the power theme, statistics and social studies can be integrated and taught together. In this way, learners can experience authentic cases in which the target skills and knowledge are used in real life, and understand interrelationships among the topics and content areas.

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Learning Contract

SEE BEHAVIORISM

Learning Hierarchy

SEE ALSO PREREQUISITE SKILLS and SEQUENCING

In 1968, Robert Gagné published one of his seminal works, "Learning Hierarchies." In this paper, Gagné graphically charts the arrangement of learning outcomes and illustrates how they relate to each other and to prerequisite knowledge and thus lays a foundation for instructional design and curriculum development (Richey, 2000). Learning hierarchies contend that there is a hierarchical relationship that exists among intellectual skills, and that learners must first successfully complete any sub-ordinate outcomes before they can successfully achieve the next level of outcomes (Reiser, 2001).

Commonly used as a tool to sequence intellectual skill outcomes, learning hierarchies have been applied within the field in a variety of ways (Fields, 2000). Instructional designers conduct analyses through assessments of learners' entry knowledge and skills and plan instructional events to build upon this prior knowledge. The designers' decisions regarding the order in which content is presented is often based on learning hierarchies. The emphasis on prerequisite knowledge has led to research on the role prior knowledge plays in acquiring new skills (Woodward & Galagedera, 2006). The study of the hierarchal arrangement of intellectual skills has influenced new research in knowledge structures (Ifenthaler, 2011). The study of knowledge structures has influenced efforts in knowledge mapping (Chong, 2009; Hay & Kinchin, 2008) which has ultimately improved the design of curriculum.

Some have found learning hierarchies an incomplete tool to guide decisions about sequencing instruction (Reigeluth, 1979). Others suggest that the emphasis learning hierarchies place on prerequisite knowledge leads designers to make general assumptions which can lead to a non-learner centered approach to design. However, pairing learning hierarchies with thorough learning task analyses ensures that the instructional design is targeted to the learner needs. The influence of learning hierarchies is continuing to impact research in areas such as teaching concepts and solving complex and ill-structured problems (Jonassen, 2006). As online delivery grows, learning hierarchies are being used to address deficits in prerequisite skills and guide the organization of content-rich learning objects in a virtual delivery (Laverde, Ciguentes & Rodrigeuz, 2007).

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Learning Management System

SEE FEEDBACK and INTEGRATED LEARNING SYSTEMS and MANAGEMENT SYSTEMS

Learning Object

The literature stresses the rich set of definitions of learning objects (LO). A very broad definition was proposed by Wiley (2000): “Learning Objects are defined here as any entity, digital or nondigital, which can be used, re-used or referenced during technology supported learning” (p. 4). Various authors (e.g., Parrish, 2004; Wiley, 2008) have pointed to the very general nature of this definition. Anything can be a learning object. Confronted with this variety various attempts were made to categorize the different definitions and to formulate a definition that is sufficiently encompassing and restricted.

Confronted, for instance, with the large number of papers at an ICALT conference, Rossano, Joy, Roselli and Sutinen (2005) tried to find what definitions of LO were used. They argue that different meanings are attributed to the notion when considering it from a pragmatic (looks for specific solutions), technological (oriented towards technological solutions to build LO’s) or pedagogical (considers aspects of learning) perspective. McGreal (2004) has addressed the variety by making a distinction between two dimensions in the definitions. A first dimension relates to the issue of whether or not only digital elements are considered. A second dimension pertains to the question whether only the specific use of learning is included in the definition.

This last dimension relates to the wide variety of concepts related to the notion of "learning object." Merrill (1999), for instance, prefers the notion of knowledge objects. As a working definition McGreal (2004) proposes the following:

> LOs can be defined as any reusable digital resource that is encapsulated in a lesson or assemblage of lessons grouped in units, modules, courses, and even programes. A lesson can be defined as a piece of instruction, normally including a learning purpose or purposes (p. 28).

The definition of McGreal avoids the unproductive position that anything can be called a learning object. At the same time, the definition remains very broad. It is not surprising, therefore, that in specific studies on learning objects definitions are selected that are directly linked with the actual research question. Kay and Knaack (2009) for instance, wanted to elaborate and validate a "Learning Object Evaluation Scale for Students." To do so they started with defining learning objects in a more specific manner as "Learning objects are operationally defined in this study as interactive Web-based tools that support the learning of specific concepts by enhancing, amplifying, and/or guiding the cognitive processes of learners." (p. 147). It is to be expected that either more specific concepts will be elaborated or that the variety in the definitions will prevail.

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Learning Organization
SEE ALSO KNOWLEDGE MANAGEMENT and PERFORMANCE IMPROVEMENT

As a concept, a learning organization is defined as "an organization where people continually expand their capacity to create the results they truly desire, where new and expansive patterns of thinking are nurtured, where collective aspiration is set free, and where people are continually learning how to learn together" (Senge, 1990, p. 1). From the perspective of strategic development, a learning organization facilitates the learning of all its members (Garvin, 1993). From the perspective of organizational performance, King (2001) describes a learning organization as "one that focuses on developing and using its information and knowledge capabilities in order to create higher-valued information and knowledge, to change behaviors, and to improve bottom-line results" (p.14). A learning organization should invest in its long-term sustainability instead of its short-term performance by focusing on the root causes of problems (Müller, 2011). According to Samad (2010), three main factors that may influence learning organizations include:

- People who can influence the learning process such as instructors and managers
- Mission and operating procedures to guide policies
- Culture or shared values that frame organizational actions.

Emphasizing the context of human resource development in the workplace, Kontoghiorghes, Awbrey, and Feurig (2005) identify the following characteristics of the learning organization at the implementation level:

- Open communications
- Risk taking
- Support and recognition for learning
- Resources to perform the job
- Teams
- Rewards for learning
- Training and learning environment
- Knowledge management.

Considering current perspectives on learning organizations, Watkins and Marsick (1993, 1996) propose the "Integrative Perspective" to incorporate all levels of learning, including individual, team, and organizational learning into an organization's mission and performance, which stated: "a learning organization is one that learns continuously and transforms itself… it proactively uses learning in an integrated way to support and catalyze growth for individuals, teams, entire organizations, and the institutions and communities with which they are linked" (p. 8). This integrated perspective on learning organizations consists of seven dimensions: continuous learning, inquiry and dialog, team learning, embedded system, empowerment, system connection, and strategic leadership. In support of adult learning principles, Merriam and Caffarella (1999, p.44) conclude that:

> … in learning organizations, learning--whether done by individuals, groups, or the organization as a whole--is a central, valued, and integral part of organizational life. The heart of the learning organization is the willingness of organizations to allow their employees and other stakeholders related to the organization to suspend and question the assumptions within which they operate, then create and examine new ways of solving organizational problems and means of operating. This process requires that people at all levels of the organization be willing to think within a systems framework, with the emphasis on collective inquiry, dialogue, and action. Creating learning organizations could allow educators of adults, whether they are associated with formal or nonformal settings, to develop learning communities in which change is accepted as the norm and innovative practices are embraced.

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Learning Path

A learning path can be defined as a set of learning activities that are both coherent as a whole, and meaningful to the learner or agent (Poell & Van der Krogt, 2010). A learning path emerges as a learner or agent makes sense of the diverse learning opportunities available. Generally, a learning path is described as the chosen route sequences, taken by a learner or an agent through a range of activities, which allows them to build knowledge progressively (Scott, 1991). Niedderer & Goldberg (1995) define learning path as the sequence of intermediate steps from preconceptions to target model. Central to the notion of a learning path are the learning experiences of a given learner or agent. The concept of a learning path helps us regard learning as a complete process rather than a single event, and enables us to find alternative ways to drive out time, waste and variability in teaching and training and improve performance while reducing costs (Williams & Rosenbaum 2004). Studies on learning paths help us explore and explain human behaviors during the learning processes.

Learning paths are associated with knowledge building with their structure is the result of this process. Since a learning path is the track from the initial to the final state during the learning process, it is presented as a series of links in the knowledge structure (Nakamura, Tsuji, Seta, Hashimoto, & Albert, 2011). Clement (2000, p. 1043) argues that "such a pathway would provide both a theory of instruction and a guideline for teachers and curriculum developers."

The research in e-learning is focused on automatic building of learning paths for each learner. Yangs, Liu & Huang (2010) explore how the semantic map could be used to help learners construct their personalized learning paths according to their different learning styles. In practice, learners or agents can develop their own learning paths in diverse ways through semantic mapping, with the core of learning activities and experiences recognition and arrangement. In addition, Jih (1996) discusses the impact of a learning path on learning performance in multimedia computer-aided learning and presents a prototype of a Web-based instruction system to perform personalized curriculum sequencing by simultaneously considering courseware difficulty level, learner ability and the continuity of learning pathways during learning. Kong, Ge & Luo (2007) introduce available technologies to describe and implement learning paths in Web-based e-learning settings and they develop a process control model for learning path creation.

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Learning Style

SEE FIELD DEPENDENCE AND INDEPENDENCE and LEARNER CHARACTERISICS AND TRAITS

Learning Types

SEE ALSO COMPLEX LEARNING

Learning has been categorized in a number of ways. Psychologists have viewed learning in terms of how it occurs, e.g., stimulus–response learning or rote learning. Educators have also viewed learning in terms of the instructional methods used to facilitate learning, e.g., multimedia learning or mastery learning. However, a common interpretation of learning types in the instructional design and technology field comes from a content perspective, i.e., classifications of what is learned. In this regard the types of learning serve as a basis for curriculum construction and instructional design.

One of the first efforts to identify types of learning from a content orientation occurred between 1949 and 1953 when a group of scholars sought to define taxonomies of education goals in the cognitive, affective, and psychomotor domains. We know these today as Bloom's taxonomies. Each of these groups includes subcategories of content goals and objectives which are arranged hierarchically in terms of complexity (Richey, Klein & Tracey, 2011). The cognitive domain, for example, includes six main categories: knowledge, comprehension, application, analysis, synthesis, and evaluation (Bloom, 1956).

Although greatly influenced by the work of Bloom and his colleagues, Gagné developed another configuration of learning tasks. His view of the domains of learning evolved over the years. The domains include verbal information, intellectual skills (consisting of concrete concepts, rules and defined concrete concepts, higher-order rules, and problem solving), cognitive strategies, motor skills, and attitudes (Gagné, 1965, Gagné, 1972/2000; Gagné, Wager, Golas, & Keller 2005).

Merrill and Boutwell (1973) and Merrill (1983) proposed another view of learning types, also from a content perspective. They show the learning task in terms of a matrix which combines the content categories (fact, concept, procedure, and principle) and the behaviors students demonstrate when they have met the instructional objectives (remember, use, or find). This is a further expansion of Gagné's work.

Gagné and Merrill (1990) jointly expanded their types of learning configurations to include integrative goals which encompass multiple objectives and multiples types of learning tasks directed toward a common goal. Typically, these learning tasks are incorporated into a large, complex activity called an enterprise.

All of these content-oriented views of the types of learning provide support for the assumption that "there is more than one type of learning and perhaps more than one kind of memory structure" (Merrill, 1983, p. 300). Thus, there are internal conditions of learning and instructional design (especially those steps related to strategy selection) should vary dependent upon the type of learning task.

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Learning with Information
SEE ALSO INFORMATION-RICH ENVIRONMENTS and LEARNING

"Learning with information" is a construct that assumes that information itself—factual, conceptual, procedural, and metacognitive knowledge, in Anderson and Krathwohl's (2001) terms—is the basic building block for human learning. Grounded in the belief that "developing expertise in accessing, evaluating, and using information is in fact the authentic learning that modern education seeks to promote" (American Association of School Librarians and Association for Educational Communications and Technology, 1998, p. 2), the construct addresses the ways in which the organization and presentation of information in any format can enable and constrain learning.

Marchionini (1995) defines information as "anything that can change a person's knowledge" and notes that it "includes objects in the world, what is transferred from people or objects to a person's cognitive system … and the components of internal knowledge in people's minds" (p. 5). This definition of "information"—from an information scientist—is strikingly similar to contemporary definitions of "learning" supplied by cognitive scientists. In fact, one can easily define learning with terms from Marchionini's definition: learning consists of "changing [one's] knowledge" by creating structures through encountering "objects in the world," transferring them to personal "cognitive system(s)," and forging them into "components of internal knowledge." Learning, then, is basically about building structures based on information. It is both the process and the outcome of using information to make meaning.

While this complementarity between "learning" and "information" seems clear, only limited work has been done specifically to bring together theory and research from the fields most directly connected with each: instructional design and information science. Research by Eisenberg and Small (1993), Large, Beheshti, Breuleux, and Renaud (1994, 1995), and Neuman (1993, 1995) was among the earliest to address the issue; Mayer's (1999) instructional-design model is information-based, although it doesn't make explicit the connection between learning and information use.

More recently, Cromley and Azevedo (2008), Hill and Hannafin (2001), Lee, Lim, and Grabowski (2008), Lim and Tay (2003), Hannafin, Hannafin, and Gabbitas (2009), Hannafin and Hill (2008), and Neuman (2011a, 2011b) have continued to explore the area; Kuhlthau, Maniotes, and Caspari's (2007) promotion of "guided inquiry" also assumes that information is at the heart of learning. *Education and Information Technologies*, which first appeared in 1996, is the sole academic journal devoted to the topic; Ford's 2008 announcement of a field he calls "educational informatics" moves the connection between instructional design and information science even closer.

A number of current developments suggest that both researchers and practitioners are developing a deeper understanding of the relationship between learning and information use. Arguably the most influential of these is the Common Core State Standards initiative, whose "key design considerations" include the following paragraph:

> To be ready for college, workforce training, and life in a technological society, students need the ability to gather, comprehend, evaluate, synthesize, and report on information and ideas, to conduct original research in order to answer questions or solve problems, and to analyze and create a high volume and extensive range of print and nonprint texts in media forms old and new. The need to conduct research and to produce and consume media is embedded into every aspect of today's curriculum (Common Core Standards Initiative, 2010, p. 4).

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Libraries

SEE INFORMATION STORAGE

Line

SEE VISUAL MESSSAGE DESIGN

Literacy

SEE ALSO VISUAL COMPETENCY

A perhaps apocryphal story tells of Sir William Curtis (1752–1829), Lord Mayor of London, delivering a toast at a school dinner (ca. 1825) using the phrase "Reading, 'riting, and 'rithmetic." This phrase was later captured in the popular 1906 American song (Edwards & Cobb, 1906):

> School days, school days,
> Dear and golden rule days,
> Readin', 'ritin, and 'rithmetic,
> Taught to the tune of a hickory stick.

Ironically "Reading, 'riting and 'rithmetic" became the popular definition of literacy, but in the minds of most educators this is the antithesis of a modern definition of literacy. Nevertheless and on the contrary, taking the words semiotically, reading can be interpreted broadly as decoding, and writing as encoding. In that sense, the old definition seems surprisingly relevant today. Not only can the term be applied to any encoding/decoding situation, but also adds, in the word "rithmetic" a recognition of mathematical and scientific literacy, as a basic component of being literate.

UNESCO (United Nations Educational, Scientific and Cultural Organization) provides what has become a standard recognized definition of literacy as:

> … the ability to identify, understand, interpret, create, communicate, compute and use printed and written materials associated with varying contexts. Literacy involves a continuum of learning to enable an individual to achieve his or her goals, to develop his or her knowledge and potential, and to participate fully in the wider society (UNESCO, 2008, p. 18).

The meaning and the domains of literacy have expanded significantly. Terms such as visual literacy, media literacy, television literacy, e-literacy, digital literacy, and twenty-first century literacy are all attempts to either re-focus or expand the meaning of literacy into other modes of communications (Hoechsmann & Poyntz, 2012). Of course, this expansion of the term "literacy" is not only a twenty-first century phenomenon since visual literacy, film literacy, radio literacy and television literacy all date from the twentieth century.

Contemporary Web 2.0 technologies have helped move the concepts of "reading" and "writing" from the classic model in which writers, producers and editors are a small elite group, to a supposed democratic form whereby we are all readers and writers. Society has not yet worked out all the ramifications of what happens when everyone is a reader and a writer, and the classic role of editor disappears.

Nearly all scholars are currently talking about the ever expanding definition of literacy as they search for a broader definition. Terms such as "multimodalities" (Kress, 2010) and "transliteracies" illustrate that exploration. The latter term is defined as "the ability to read, write and interact across a range of platforms, tools and media from signing and orality through handwriting, print, TV, radio, and film, to digital social networks" (Ipri, 2010, p. 4).

In a parallel fashion, the North Central Regional Educational Laboratory identifies eight digital age literacies as basic, scientific, economic, technological, visual, information, multicultural, and global (NCREL, 2003). Missing from their list is "political literacy," the absence of which reverberates in constant local and global crises.

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Localized Instruction

SEE CULTURE-SPECIFIC DESIGN

Locus of Control

SEE ATTRIBUTION THEORY

Lurking

SEE ON-LINE BEHAVIOR

M

Management Systems
SEE ALSO KNOWLEDGE MANAGEMENT

According to the International Organization for Standards (2011), a management system "refers to what the organization does to manage its processes, or activities, so that its products or services meet the objectives it has set itself, such as satisfying the customer's quality requirements, complying with regulations, or meeting environmental objectives" (Management Systems section, para. 3). Hence, management systems are proactive means designed to better enable organizations to attain their goals.

Management systems are ubiquitous across industries and education, and are perhaps most notably visible in sectors such as waste, environmental, energy, risk, and quality. At this high level of management systems, standards can play a significant role in their development by creating a model that "incorporates the features on which experts in the field have reached a consensus as being the international state of the art" (International Organization for Standards, 2011, Management Systems Standards section, para. 4). These standards help to drive management system features at a more micro level within a field or domain. For example, the popularity of the quality management movement has led to the use of such quality improvement methods as Six Sigma, lean manufacturing, quality circles, and total quality management.

Specific management systems that are particularly germane to educational technology are those that align to the learning function of organizations. These include learning management systems (LMS), course management systems (CMS), and knowledge management (KM).

Learning management systems have become necessary components of on-line education to assist in the management of global and institutional issues, administration, pedagogy, costs, accreditation, assessment, enrollment, as well as progress flexibility (Virkus, 2004). An alternative view is offered by Watson, Lee, and Reigeluth (2007) who define both major and minor roles of an LMS. Major roles are recordkeeping, planning, instruction, and assessment. Secondary roles are communication, general student data, school personnel information, and LMS administration.

Course management systems are Web applications that provide tools to create course Web sites, control access to only enrolled students, as well as supply instructional tools such as forums, quizzes, and grade books (Cole & Foster, 2007). These applications are generally packaged as a product for use by educational bodies, such as universities and colleges, and are represented by products such as Blackboard or Moodle.

Knowledge management systems are the sets of activities and processes to collect, develop, share, and apply knowledge within an organization to gain and sustain a competitive advantage (Mihalca, Uta, Andreescu, & Intorsureanu, 2008; Petersen & Poulfelt, 2002). KM has contributed to the growth of practical methodologies such as communities of practice, concept mapping, and knowledge acquisition. The educational use of KM has been on the rise since 2005 (Uzunboylu, Eriş, & Ozcinar, 2011), an example of which is the implementation of KM as a support mechanism for teachers to supply them with both instructional tools and feedback mechanisms (Bain & Swan, 2011).

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Also See Additional Resources for Further Information on this Subject

Mashups
SEE SOCIAL COMPUTING and WEB 2.0

Massively Multiplayer Online Games
SEE DIGITAL GAME-BASED LEARNING

Mastery Learning
SEE ALSO INDIVIDUALIZED INSTRUCTION

Mastery learning suggests that given the appropriate learning conditions, quality instruction and sufficient time, nearly all students can reach a high level of achievement (Bloom, 1976; Carroll, 1963; Guskey, 2010). Bloom (1976) states it is the "sheer amount of time spent in learning that accounts for levels of learning" (p. 51). He further notes that the amount of time required for learning is "likely to be affected by the students' aptitudes and verbal ability and the quality of the instruction he receives in class and out of class" (p. 51).

Carroll (1989) identifies five variables that impact mastery learning—aptitude, defined as the amount of time a student needs to learn a task; opportunity, defined as the amount of time allowed for learning; perseverance, defined as the time the student is willing to spend learning; the quality of the instruction; and the learner's ability to understand the instruction. Carroll (1963) notes that if time spent learning is equal to or greater than the time required for learning, mastery will occur. However, he views time as a function of aptitude, quality of instruction and the learner's ability to understand the instruction.

Zimmerman and Dibenedetto (2008) discuss mastery with respect to individual learning criterion. They suggest using a criterion mastery model that assesses performance based on individual growth rather than a comparison with other students. Zimmerman and Dibenedetto (2008) explain "the purpose of a criterion mastery model is to measure students' academic growth rather than their stable individual differences" (p. 207). Their approach, like those of Carroll and Bloom, focuses on the ability of the individual learner and the relationship between the time required for learning, the time allotted for learning and the quality of the instruction.

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Mathematical Model of Communication

SEE ALSO COMMUNICATION THEORY AND MODELS

Communication theory had its origin in the problem to transmit telegraph and telephone messages from one point to another. The problem was to either transmit every bit of every message from point A to point B or to transmit a smaller number of bits of information but to still maintain a quality transmission. Telegraph speed problems were described in Harry Nyquists' 1924 paper and Ralph Hartley (1928) used the term information as a measurable quantity. While these works preceded those of Claude E Shannon in 1948, it was his treatise, "A Mathematical Theory of Communication," which described a concept known as information entropy. Based on probability and deterministic concepts, information theory was devised to measure the amount of uncertainty in a transmission. The uncertainty could be caused by the sender, the receiver or the medium between them. Bell Labs was in the process of laying trans-Atlantic telephone cable between Europe and North America after World War II. Shannon was working to reduce the amount of cable necessary to complete calls between the two continents. Information entropy was developed to calculate the amount of uncertainty in the transmission. If the amount of uncertainty could be identified, then the telephone company could adjust the amount of cable to dedicate to a call. Less uncertainty meant that fewer strands of cable could be used to transmit a telephone call.

Shannon (1951) later published a manuscript on the connection between cultural cognition and probabilistic cognition. Moser (1971) started to use information theory to investigate conversations between students enrolled in science education classes. He found that the use of information entropy could be a useful tool to measure the amount of uncertainty in the conversation. He then developed a series of extensions to Shannon's concept of entropy and extended the notion of information (communication) theory (Moser, 1972).

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Media

SEE ALSO INFORMATION RESOURCES and MULTIMEDIA LEARNING and RICH MEDIA

The classic interpretation of media, and indeed the most cited, in the context of educational technology is provided by Clark (1983), "The best current evidence is that media are mere vehicles that deliver instruction but do not influence student achievement any more than the truck that delivers our groceries causes changes in our nutrition." (p. 446). Media elements can be defined in general as the audio and visual techniques used to present words and illustrations. Media elements include text, audio narration, music, still graphics, animations, photographs, and video. Media elements, combined with effective instructional methods, guide learners to effectively process and assimilate new knowledge and skills (Clark & Mayer, 2008).

Digital media technologies on computers, delivered via the Internet, or accessed using mobile devices such as smartphones and tablet computers provide the ability to combine media elements in what is commonly referred to as multimedia. In its most basic form, Mayer (2009) defines multimedia as the presentation of material using words and pictures, corresponding to dual channel encoding of verbal and pictorial (visual) information.

New media is a term that is applied to interactive multimedia in the context of the Web 2.0. The distinguishing characteristic of new media is the ability of the learner or viewer to interact directly with the media by manipulating the presentation format and context, and the ability to alter the media message in real time through the use of meta-data layers and tags.

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Media Planning

SEE MEDIA UTILIZATION

Media Utilization

SEE ALSO MEDIA and TECHNOLOGY-ENABLED LEARNING and TECHNOLOGY-ENHANCED LEARNING ENVIRONMNETS

Media selection decisions occur during the design of instruction, concurrent with decisions on methods, and are based on learning effectiveness as well as feasibility and practicality in the context of the learning environment. Utilization of media offers a means of sequencing, adding interactivity, and providing an affective and esthetic component to learning (Seels, 2011). Effective media utilization should thus spur knowledge creation by enabling learners to explore, expand, and enhance their own capabilities. Effective media utilization is also discussed in Merrill's (2009) First Principles of Instruction. Specifically, the demonstration principle stipulates "Learning from demonstrations is enhanced when learners observe media that is relevant to the content" (p. 44).

General guidelines for effective planning and use of media for instruction are summarized by Merrill (2009, pp. 46–47) in the following set of basic principles:

- Include both words and graphics as long as the graphics convey information that is being taught and are not merely decorative.
- Place corresponding words and graphics near each other.
- Present words as audio narration rather than onscreen text.
- Presenting words as both text and simultaneous audio narration can interfere with learning.
- Adding interesting, but unnecessary, material can interfere with learning.

Additional guidance for planning and utilization of media is provided by Clark and Lyons (2004). It is natural to question whether learning from one medium shows greater gains than another. In media comparison studies, the main independent variable is the medium that is used for delivering the content whereas the main dependent variable is tied to the learning outcome. Looking at hundreds of media comparison studies, Clark (2001) concluded that media comparison of this type is not a fruitful form of research. The rationale for this is that the instructional method causes learning to occur, and not the medium. A generalization of this principle is provided by Mayer (2009), showing instructional methods that are found to be effective in book-based media are also effective with computer-based media.

In summary, we know that media decisions are linked with method selection in the design of effective instruction. Additional factors related to learner characteristics and the environment must also be taken into consideration. Guidance for media utilization has been provided in this definition along with additional resources for the practitioner.

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Also See Additional Resources for Further Information on this Subject

Memory

SEE ALSO INFORMATION PROCESSING THEORY and MNEMONIC and SCHEMA THEORY

Human memory is a topic of research interest from many perspectives, including psychology and physiology. The term itself is used to refer collectively to the storage, maintenance, and recovery of past experiences. Furthermore, what is remembered must have first been learned, that is, experiences are analyzed perceptually and cognitively before they can be stored. Different theorists have focused on specific aspects of these several interrelated processes (e.g., Ashcraft & Radvansky, 2009; Baddeley, Eysenck, & Anderson, M. C., 2009).

A common characterization concentrates on three stages overall. First, experiences must be *encoded*, which involves sensation, perception, and analysis, making sense of the experience. This is often assumed to occur in a limited capacity processing system, working memory, roughly analogous to immediate consciousness or a desktop.

Second, some experiences from working memory will be *stored* in a more permanent form of memory. Metaphors to conceptualize this human store have varied over the centuries, typically drawing on the contemporary technologies used to store information otherwise, for example, wax tablets, paper and pencil, switchboard, library, file cabinet, cameras, and computer disks and hard drives.

A critical question is the format of what is stored, specifically whether it is a *literal* recording, that is, an exact copy of the experience, or is it instead some *schematic* summary of the experience. Considerable recent evidence is consistent with schematic knowledge representation.

Third, the memory must be demonstrated in performance after a period of time, with successful *retrieval*, using some deliberate effort or perhaps automatic performance. This success can be interpreted as *reproducing* the replica, like selecting a photograph from a book, and fully re-experiencing the original cognition (actually re-cognize). However, considerable evidence indicates that retrieval is often a *reconstruction*, with details generated as needed given access to the stored summary (e.g., Loftus & Palmer, 1974).

Memory has been a voluminous research area for over a hundred years, starting with the seminal research by Ebbinghaus (1885/1913). Some have focused on the issue of lost memories, that is, why forgetting occurs, whereas other research has focused on the retained content. A sampling of the topics examined would include different types of memory, such as semantic memories that derive from a shared language versus episodic memories that derive from personal experiences (e.g., Tulving, 1972), explicit memories that we can deliberately access versus implicit memories that are automatic (sometimes labeled declarative versus procedural memories, e.g., Schacter & Tulving, 1994), and prospective memories to do something at a future time versus the usual retrospective memories for past events (e.g., McDaniel & Einstein, 2007). In addition, there are special topics of interest, such as autobiographical memory and flashbulb memories involved with emotional (experiences). Furthermore, there are many topics involving memory improvement, including mnemonics and meta-memory. Finally, neuropsychologists have renewed their interests in memory with recent advances in brain function imaging techniques.

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Also See Additional Resources for Further Information on this Subject

Mental Effort

SEE COGNITIVE LOAD

Mental Model Progression

SEE ALSO ELABORATION SEQUENCING and SEQUENCING

Mental model progression could be considered a macro-level instructional strategy or a meso-level sequencing strategy (van Merrienboer, 1997). Mental model progression is "an approach to meso-level sequencing in which case types, or categories of problems and worked-out examples, are based on increasingly more elaborated versions of supportive knowledge (conceptual models, causal models, goal-plan models, or mental models)" (van Merrienboer, 1997, p. 317).

Since a sequence of case types (units or modules) typically is in simple to complex order, this mental model progression approach is closely related to Reigeluth's Elaboration Theory and his whole-part approach (Reigeluth, 1987). Zooming in and out on the whole picture can help learners to acquire gradually both the detail and breadth desired.

The sequence bases case types (units or modules) on a sequence of mental models with increasingly more elaborated versions of supportive knowledge (van Merrienboer, 1997). Mental model progression starts with a model having the most simple, representative, fundamental, and concrete ideas. Subsequently, later models add more complexity or detail to the former models and elaborate on them. This elaboration or progression process continues until learners reach the required behavior. Models are usually causal models; however, they can be goal-plan hierarchies or conceptual models.

White and Frederiksen (1990) presented an example of a mental model progression in the area of designing and troubleshooting electrical circuits (see Table 1).

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Table 1 Case types deduced from a progression of mental models (White & Frederikson, 1990)

Level of elaboration	Case type
Model level 1: Reasoning about voltage	
1.1. Zero-order model – Basic zero-order circuit principles – Types of conductivity	1. Cases requiring understanding of how voltages are divided in circuits
1.2. First-order model – Concept of feedback – Analog circuits	2. Cases requiring the detection and understanding of feedback
1.3. Quantitative model – Kirchov's Voltage Law – Voltage dividers	3. Cases requiring learners to compute voltages across different points
Model level 2: Reasoning about current flow	
2.1. Zero-order model – Basic principles of current – Current and absence/presence of resistance	4. Cases requiring reasoning about current flow in parallel circuits
2.2. First-order model – Relating voltage, current, and resistance – Propagations in transistor circuits	5. Cases requiring direct reasoning about changes in current in both series and parallel circuits
2.3. Quantitative model – Ohm's law – Kirchov's current law	6. Cases requiring the algebraic manipulation of equations

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Message Design

SEE ALSO CHUNKING ad COGNITIVE LOAD and VISUAL MESSAGE DESIGN

Fleming and Levie (1978) define a message as "a pattern of signs (words and pictures) produced for the purpose of modifying the cognitive, affective, or psychomotor behavior of one or more persons" (p. ix). They further define design as "a deliberate process of analysis and synthesis that begins with a communications problem and concludes with a plan for an operational solution" (p. ix). Finally, Fleming and Levie conclude that instructional message design is "the process of manipulating, or planning for the manipulation of, a pattern of signs and symbols that may provide the conditions for learning" (p. ix).

Our ability to use new technologies to create more complex, dynamic instructional messages has fostered significant research in the areas of information processing and multimedia theory. This has led to new principles of message design, but not basically altered the original definition. Morrison, Ross, Kalman and Kemp (2011) identify message design as the process of "creating an appropriate interface between the instructional materials and the learner" (p. 180). Seels and Richey (1994) note that the appropriate interface is not a constant, but is based on the delivery medium and learning task.

Information processing and cognitive load research has had a significant impact on how instructional messages are constructed. Farrington (2011) notes that recent research suggests working memory can only process three to four individual or chunked items at a given time. Instructional messages that exceed this limit result in cognitive overload, limiting learning. Farrington (2011) adds that cognitive load can be reduced by altering the design of the message, "streamlining the way information is presented and changing the nature of traditional learning tasks" (p. 115). Kalyuga (2011) suggests altering the message by "selecting learning tasks that are not too complex relative to learner levels of expertise" (p. 3).

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Metacognition

SEE ALSO COGNITIVE PROCESSES and COGNITIVE STRATEGIES and SELF-REGULATION

Metacognition is the "knowledge that a person has of his own cognitive processes" (Thiede, 2003, p. 1470); it is "the monitoring and control of thought" (Martinez, 2006). A seminal definition described metacognition as the knowledge and understanding of cognitive phenomena including cognitive monitoring and evaluation, and three knowledge constructs—self-knowledge, task knowledge, and strategy knowledge (Flavell, 1979). More recent definitions have expanded to include self-regulation. Metacognition encompasses rational and emotional cognitive processes—the former employing problem solving and critical thinking and the latter, self-regulation (Martinez, 2006). Similarly, others have defined metacognition as the cognitive parts of self-regulation encompassing "affective, motivational and social elements" (Whitebread et al. 2009, p. 64). Metacognition (i.e., how students process, construct and understand material) is cognition regulation that has been contrasted with motivational regulation which is "the students' willingness to process information, … construct meaning, or … continue working" (Wolters, 2003, p. 192).

Some definitions beg the question of whether metacognition is a self-regulation component (Schunk, 2008). Furthermore, metacognition has often been used interchangeably with self-regulation and self-regulated learning in the literature, although operational definitions or component construct combinations have often been unique (Dinsmore, Alexander & Loughlin, 2008). Nonetheless, among 39 studies published since 2006 with metacognition definitions, about half or more included the same three core components—monitoring, control, and regulation (Dinsmore et al., 2008).

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Meta-Evaluation
SEE EVALUATION

Microcast
SEE TECHNOLOGICAL COMMUNICATION

Mixed-Mode Learning
SEE BLENDED LEARNING

MMORPGs
SEE VIRTUAL WORLDS

Mnemonic
SEE ALSO COGNITIVE STRATEGIES and MEMORY

A mnemonic or mnemonic device is a micro-level strategy for remember-level learning in Bloom's taxonomy (Bloom, Engelhart, Furst, Hill & Krathwohl, 1956; Krathwohl, 2002). According to Bellezza (1981), "a mnemonic device is considered a strategy for organizing and/or encoding information with the sole purpose of making it more memorable" (p. 252). For example, in order to remember the colors of the rainbow, the first letters of the colors can be organized into a more memorable phrase; "Richard Of York Gave Battle In Vain." Mnemonic devices are often accompanied by visual imagery to aid retention of the mnemonic device (Bower, 1970).

Numerous methods of mnemonic devices have been devised. Widely used methods include the Peg-word Mnemonic, First-letter Recoding, Story Mnemonic, Rhymes, Songs, and so on. Bellezza (1981) has summarized and classified various mnemonic methods.

In the late 1960s to 1970s, various mnemonic strategies were devised and tested, and the results showed dramatic improvement in retention performance (for a review, see Bellezza, 1981). Despite the remarkable results, interest in mnemonic devices has declined, because mnemonic devices are only concerned with rote memorization rather than conceptual understanding. However, mnemonic devices have been frequently and widely used in fields where memorization is an important step to mastery, like foreign language education for vocabulary learning (e.g., Gu & Johnson, 1996) and medical education for parts of the body.

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Mobile Devices and Functions

SEE ALSO MOBILE LEARNING

Mobile devices can be defined in terms of physical characteristics and functions; the main characteristic is portability and the main purpose is accessing data at any time or any place. Common types of mobile devices include cell phones, Web-enabled smart phones, personal digital assistants (PDA), media players, pagers, personal navigation devices, e-reader devices, digital cameras, classroom response systems (clickers), handheld game consoles, ultra-light laptops, and tablets (Chuang, 2009; El-Hussein & Cronje, 2010; Park 2011).

Mobile devices are portable in terms of both size and ability to function wirelessly. Most mobile devices include output features such as display screens and sound. They usually include an input method such as a keyboard, stylus, or touchscreen. Cell phones currently are the most popular mobile devices, and according to the recent Pew *Internet & American Life* reports (Horrigan, 2009; Smith, 2011), 83 % of American adults own a cell phone and 35 % of all American adults own a smartphone. Additionally, 25 % of smartphone users access the Internet mainly on their phones rather than traditional computers. The prolific use of mobile technology underscores the importance of adopting mobile learning in education (Jeng, Wu, Huang, Tan, & Yang, 2010; Kukulska-Hulme, Shaples, Milrad, Arnedillo-Sánchez, & Vavoula, 2009; Shih, Chu, Hwang, & Kinshuk, 2011).

Mobile devices perform a variety of functions including social networking, productivity, communication, entertainment, and Internet use. Additional functions of some mobile devices include data capture technology such as Radio Frequency Identification (RFID), barcodes, Optical Character Recognition (OCR), geotagging, and smart cards. The data capture technology, or "embedded intelligence," provides learning opportunities in which students can interact with their environments

(Laine, Vinni, Sedano, & Joy, 2009, p. 4). For example, students might use mobile devices to read RFID tags in order to identify types of plants, match artists to paintings, or identify common objects in another language. Data capture technology creates a context-sensitive learning environment and active learning (Liu & Hwang, 2010). The portability and functionality of mobile devices provide learners with a sense of control or ownership which can be motivating; additionally, mobile devices integrate learning into the learner's daily life outside of the classroom (Jones & Issroff, 2007; Traxler, 2009; Wali, Winters, & Oliver, 2008).

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Mobile Learning

SEE ALSO DISTANCE EDUCATION AND LEARNING and MOBILE DEVICES AND FUNCTIONS

Definitions of mobile learning (m-learning) are still developing and have emphasized various attributes depending on the purposes of those defining it (Belshaw, 2010; Peng, Su, Chou, & Tsai, 2009). Within the literature of the past decade, definitions have evolved from techno-centric to context-centric to learner-centric focus. A single definition encompassing these might include "any type of learning that takes place in learning environments and spaces that take account of the mobility of technology, mobility of learners and mobility of learning" (El-Hussein & Cronje, 2010, p. 20). Finally, in moving towards a unified definition of m-learning, a new term frequently appears in the literature: ubiquitous learning, or u-learning (Jeng, Wu, Huang, Tan, & Yang, 2010; Peng et al., 2009).

One of the earliest definitions of m-learning places it within the broader category of e-learning, differentiated through the use of mobile devices (Chuang, 2009; Park, 2011; Traxler, 2009; Shih, Chu, Hwang, & Kinshuk, 2011; Wali, Winters, & Oliver, 2008). One limitation of conventional e-learning is the limited access to learning due to stationary computing tools. M-learning can extend the learner's experience by making resources available at any time and in any place (Dyson, Litchfield, Lawrence, Raban, & Leijdekkers, 2009; Laine, Vinni, Sedano, & Joy, 2010). In this techno-centric view, the emphasis is placed on the tools, which make existing learning environments and materials available on demand through the use of portable, mobile devices.

Other definitions emphasize context in terms of physical location and social situation including informal learning (Traxler, 2007; Wali et al., 2008). Sharples, Taylor, and Vavoula (2007) suggested that communication is the central focus of m-learning, and therefore context is the key attribute defining it. In this perspective, m-learning consists of the "the processes of coming to know through conversations across multiple contexts among people and personal interactive technologies" (para. 12). The context-centric definition emphasizes m-learning that can aid the learner in connecting various life contexts for learning purposes (Kukulska-Hulme, Sharples, Milrad, Arnedillo-Sánchez, & Vavoula, 2009; Park, 2011).

The rapid development and adoption of personal mobile technology has led to pervasive use (El-Hussein & Cronje, 2010; Sharples et al., 2007). This ubiquitous nature of mobile technology has been noted in the educational research literature and appears to be gaining impact as the newest direction for the definition of mobile learning (Liu & Hwang, 2010), referred to as ubiquitous learning or u-learning. U-learning adds interaction with sensor technologies such as RFID readers, tags, GPS to the definition of mobile learning. Like the other models, u-learning emphasizes the "anytime, anywhere" benefits of mobile technology but also seamless integration in the learners' day-to-day lives (Chuang, 2009; Looi, et al., 2010; Yang, Okamoto, & Tseng, 2008). U-learning encourages distributed learning, with learners facilitating their own learning outside of the classroom, communicating across contexts, and accessing and creating relevant and rich content via ubiquitous technologies (Jeng et al., 2010; Shih et al., 2011). In this definition, the emphasis is less on mobility and more on connectivity, and it is the learner who is mobile rather than the device (Belshaw, 2010; Liu & Hwang, 2010; Woodill, 2010).

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MOOs

SEE VIRTUAL WORLDS

Motivation

SEE ALSO ATTRIBUTION THEORY and CONTEXT and LEARNER CHARACTERISTICS AND TRAITS and SELF-EFFICACY and SELF-REGULATION

Motivation, a well-researched construct in education, may be "defined as a set of interrelated beliefs and emotions that influence and direct behavior" (Martin & Dowson, 2009, p. 328). Motivation has also been simply defined as "why people think and behave as they do" (Graham, Lepper, Henderlong, & Pintrich., 2002, p. 1690), and as such it incorporates the external and internal states or conditions that initiate, direct and engage one in certain thoughts, behaviors or activities. More specifically, learner motivation has been defined as an internal disposition manifested through effort and persistence (Klein, Spector, Grabowski, & de la Teja, 2004). Motivation is personal, activating, energizing and directed; it is an internal process that instigates the learner's action and fosters persistence to achieve the learner's goal (Mayer, 2011).

Educational researchers have defined motivation by combining a variety of constructs into models which explain motivation. While concise and operational definitions usually allude to learner attitudes, persistence and observable behavior, motivation models typically describe motivation in terms or processes and interrelated factors. These models include self-efficacy, attributions, control, valuing, goal orientation, self-determination, achievement need, self-worth and self-regulation (Martin, 2007). One of the more inclusive models is Vallerand's (2011) Multilevel Personality in Context model which is built around multiple social psychological and personality determinants of motivation; these elements have both extrinsic and intrinsic factors and exist on global, contextual, and situational levels.

The instructional environment incorporates unique contextual and situational factors which describe learner motivation. However, when extrinsic factors cannot fully explain motivation, learner interpretations and perceptions of these factors are required to explain learner motivation (Hamachek, 1987). Motivation has been measured with a single construct to explain task-specific motivation. An example of this are the measures used in many studies supporting computer self-efficacy effects on learner behavioral and cognitive processes (Moos & Azevedo, 2009).

Motivation is considered an important part of the design process (Cheng & Yeh, 2009; Small, 2011). Motivational antecedents and outcomes may be facilitated or hindered by instructional design and technology (Chen, Jang, & Branch, 2010; Guthrie, Wigfield, & VonSecker, 2000; Mayer, 2011). Keller (1987, 2010) distilled instructional motivation attributes into the ARCS model of instructional design which highlights four aspects of motivation—attention, relevance, confidence, and satisfaction that can be measured with a self-report. The self-report profile corresponds to specific instructional strategies that have been tested as motivational interventions (Bolliger, Supanakorn, & Boggs, 2010; Huett, Young, Huett, Moller, & Bray, 2008).

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Motivation Design Models

SEE INSTRUCTIONAL DESIGN MODELS

MUDs

SEE VIRTUAL WORLDS

Multicast

SEE TECHNOLOGICAL COMMUNICATION

Multichannel Instruction
SEE ALSO COGNITIVE LOAD and DUAL CODING THEORY and MULTIMEDIA LEARNING

Richey, Klein and Tracey (2011) define multichannel instruction as "teaching-learning activities that deliver messages through more than one vehicle or medium, typically both audio and visual" (p. 192). Krippel, McKee and Moody (2010) add the theory of multichannel communication "confirms that when information is presented by more than one channel, there will be additional reinforcement, resulting in greater retention and improved learning" (p. 62). Numerous theories address the benefits and limitations of multichannel instruction. They include dual coding theory, cue summation theory and cognitive load theory.

Paivio's dual coding theory attempts "to explain how the mind processes information" (Akbiyik & Akbiyik, 2010, p. 332). Akbiyik and Akbiyik (2010) explain this theory suggests that human memory consists of two channels—one that processes verbal information and one that processes nonverbal information. It is important to note that Paivio does not distinguish between visual and auditory. He asserts that both written and spoken words are processed by the verbal channel. Akbiyik and Akbiyik (2010) further explain that dual coding theory states that information that is received and processed by both channels will be learned more effectively than information received by either one or the other independently. Dual coding theory therefore supports the use of multichannel instruction.

Moore, Burton and Myers (2004) address the relationship between multichannel instruction and cue summation theory. They state "the cue summation principle of learning theory predicts that learning is increased as the number of available cues or stimuli is increased" (p. 984). Dwyer (1978) agrees, stating "learning will be more complete as the number of cues in the learning situation increases" (p. 6). It is important to note that the benefits of cue summation are directly related to the types of cues employed in the instruction. The use of multiple complementary or redundant cues has been shown to increase learning while the use of multiple incompatible cues has been shown to have the opposite effect (Moore et al., 2004). Cue summation theory supports the use of multichannel instruction only when compatible cues are employed.

Chang, Hsu and Yu (2011) note it is necessary to review "cognitive load theory to understand the possible implications of multiple-channel processing on cognitive structures" (p. 188). Cognitive load theory is based on the idea that information processing resources are limited. Sweller (1999) explains "instruction should be designed to minimize any unnecessary burdens on working memory" (p. 37). He adds "an instructional design will be deficient to the extent that it requires learners to engage in cognitive processes that are irrelevant" (p. 37). Cognitive load theory does not argue against the use of multichannel instruction. Like dual coding and cue summation theory it supports the benefits of multichannel instruction, but only when used purposefully.

Advances in technology have, and will continue to, increase the instructional designer's ability to employ multichannel instruction in learning events. The challenge is to maximize the benefits of multichannel presentations of instructional content without exceeding the learner's information processing capabilities. Multichannel instruction should be used only if it enhances rather than detracts from the instructional message.

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Multimedia
SEE MEDIA

Multimedia Learning
SEE ALSO INTEGRATED TECHNOLOGIES and MEDIA and MULTICHANNEL INSTRUCTION and VISUAL AND PICTORIAL LEARNING

Multimedia learning has been defined is several ways over the last few decades. Clark and Fledon (2005) argue that it is important to look at the definition of multimedia in order to understand the meaning when the word is linked with learning.

Mayer (2005) presents three scenarios on the possible understanding of the term multimedia: images project on a screen with music or sound delivered via speakers; sitting at a computer which provides the graphics and the spoken word coming from a speaker (online learning); or watching a PowerPoint presentation while listening to the speaker. These three scenarios highlight Mayer's use of a broad definition to encompass all of the possible interpretations of the word; therefore, multimedia presents both words (such as spoken text or printed text) and pictures (such as illustrations, photos, animation, or video).

Learning, according to Mayer (2005), is the ability to construct knowledge. The term multimedia brings to mind several possible understandings of the word when it is applied to the learning environment. From this, one can deduce that multimedia learning happens when students combine the text and the images together to learn.

Mann (2006) states that learning from multimedia starts "when an adult or child watches a graphic or animation, listens to speech, some music or a sound effect, reads some text, focuses his or her attention to learn and send data to and from their long-term memory" (para 1). In their work on history and multimedia learning, Wiley and Ash (2005) wrote that multimedia learning is usually associated with CD-ROMs or the Internet where learners can find a combination of text, pictures, movies, and other media used to provide the information.

Mayer (2003) argues that the potential of multimedia learning is achieved through this combination of words and pictures. However, in order for learning to take place, the learner must organize the words and pictures using three required processes: selecting (conversion of images or text to verbal representations), organizing (presentation of verbal and pictorial models), and integrating (connect what they see and hear to prior knowledge).

It is this combination of materials in a multimedia environment that are augmented to "seduce the individual into learning" (Moos & Marroquin, 2010, p. 265). Thus, multimedia learning is a combination of visual, text, and sound which the learner processes through selecting, organizing, and integrating to acquire knowledge.

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Multimedia Representations of Research, Teaching, and Learning

Concern with the multimedia representation of findings from research, teaching and learning has increased in recent years since the conventional text-based representation of research, teaching and learning does not go far enough for dissemination and sharing in the digital and global age (Goodyear, 2005; Sharpe, Beethham & Ravenscroft, 2004). In this case, a multimedia representation of research, teaching and learning is emerging to bridge this gap and makes the findings from research, teaching and learning more accessible and usable by academics, educators, and learners. The primary function of multimedia is representation. In a sense, there is "no multimedia without representation" (Davis, Russell, Baudin & Kedar, 1994, p. 181).

Multimedia representation of research, teaching and learning can be regarded as a branch of knowledge representation research and application which borrows many ideas, methodologies, and tools from various fields including psychology, artificial intelligence and information technology. It aims at representing knowledge from research, teaching and learning in various symbols to facilitate reasoning from those knowledge elements, disseminating and sharing them through multimedia displays to and with shareholders, and building new elements of knowledge.

In general, the most direct way in which researching, teaching and learning findings can be represented to a wide audience is via the mass media. According to the concept of knowledge representation from Davis, Shrobe and Szolovits (1993), multimedia representation of research, teaching and learning can be understood as a surrogate, a set of ontological commitments, a fragmentary theory of intelligent reasoning, a medium for efficient computation, and a medium of human expression through multimedia. As a set of ontological commitments, the significant issues for multimedia representation of research, teaching and learning include how we could represent the findings and experiences more intelligently through multimedia, how it should be evaluated, and how to avoid distortion (Hammersley, 2003).

For multimedia representation of teaching and learning, one of the most popular methods is traditional instructional design and more recently learning design through intellectual tutoring systems (ITS) and the other forms displayed by multimedia (Agostinho, 2011). Since the year 2000, more and more researchers are interested in ontological representation of learning objects through multimedia based on semantics and social networks (see Bick, Pawlowski & Veith, 2001; Qin & Finneran, 2002; Sánchez-Alonso & Frosch-Wilke, 2005; Ng, 2005).

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Multiplayer Games

SEE DIGITAL GAME-BASED LEARNING

N

Near Transfer
SEE TRANSFER

Need
SEE ALSO NEEDS ASSESSMENT

Need is a technical term defined as a gap in results (Kaufman & Thiagarajan, 1987); it is the difference between what is and what should be. Explicit descriptions of both the desired and the actual status, both sides of the measurable gap in results, are critical since a need is defined as the comparison between the two (Dick, Carey, & Carey, 2009). In the instructional design context, the term "need" often refers to a gap in learner outcomes (Kaufman & Thiagarajan, 1987) or, in an organizational or performance analysis context, need may be defined as a results gap at any of several inter- or intra-organizational levels (Kaufman, Rojas, & Mayer, 1993; Rossett, 1987). A data-based, a priori, outcome discrepancy defines the essential attribute of a need. Needs, once defined, may then be addressed by the most effective instructional or noninstructional interventions to close the outcome gap.

In a systematic design process, a need is a data-based, measurable outcome gap. Quantifying performance gaps, that is a needs assessment, can save time, money, and assure trainee needs are aligned with training objectives (Lucier, 2008). The needs and context drive the intervention decision which most appropriately resolves or ameliorates the current and desired outcomes discrepancies. Instructional or noninstructional interventions may address individual or organizational results or performance outcome gaps. Each gap defines a need.

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Also See Additional Resources for Further Information on this Subject

Needs Analysis

SEE ANALYSIS and ASSESSMENT

Needs Assessment

SEE ALSO ANALYSIS and NEED and PERFORMANCE IMPROVEMENT

Needs assessment is the process of identifying gaps between desired results and current results, and prioritizing them based on the cost to close the gap, versus the cost to ignore it. These gaps are called needs, and needs chosen for resolution can also be referred to as "problems" (Kaufman, 2000; 2006). Key figures often cited as main contributors of needs assessment methodology include Roger Kaufman, Joe Harless, Tom Gilbert, Ron Zemke and Bob Mager (Rossett, 1987).

Variations of this process have also been referred to as performance analysis (Pershing, 2006), or assumed to be part of a front-end analysis (Harless in Geis, 1986), or a *figuring things out* (FTO) study (Zemke & Kramlinger, 1982). However, Kaufman (2000) has cautioned about blurring assessment with analysis, as one seeks to identify gaps in results, while the other seeks to understand the root causes and essential elements of such gaps. If we refer to a basic Webster's definition of analysis, we find that analysis is described as the process of studying the nature of something or determining its essential features and their relations. In this sense, both needs assessment and needs analysis are part of an essential and preliminary stage in any learning and performance improvement effort.

Needs assessment provides data about gaps in results, and therefore sets up the evaluation framework to be used when evaluating the solutions that were implemented to close such gaps (Guerra-López, 2008). Needs analysis then provides data about the causal factors of the gaps, and therefore critical input about what solution alternatives should be considered to close such gaps.

It is also worth noting the distinction between a performance-based needs assessment and a training needs assessment. The purpose of a training needs assessment is to identify "the things we must know before we train…" (Rossett, 1987, p. 14), which suggests we already know training is the solution to the performance problem. From a performance perspective, needs assessments can be conducted at various levels of organizational results, including strategic (external impact), tactical (overall organizational results), and operational (internal deliverables), independently of any pre-imposed solution(s).

Within an instructional context, needs assessments could be conducted at the learner level, either looking at gaps in knowledge, or preferably, looking at gaps in human performance and behaviors first, and then seeking to identify the relevant gaps in knowledge so as to better target desired results. This is echoed by Dick, Carey and Carey (2009), who suggest that needs assessment, in the context of instructional design, begin by asking what learners must be able to do or perform, rather than what they must know.

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Also See Additional Resources for Further Information on this Subject

Negative Reinforcement

SEE REINFORCEMENT

New Media

SEE MEDIA

Nonprint Information Resources

SEE INFORMATION RESOURCES

Norm-Referenced Measurement

SEE ASSESSMENT and CRITERION-REFERENCED MEASUREMENT

O

Objective

SEE INSTRUCTIONAL OBJECTIVES

On-Line Behavior

On-line behavior is a Web-based concept used to describe the activity of someone in cyberspace. There are diverse kinds of online behaviors, including surfing, lurking, spoofing, sexting, griefing, raging, trolling, flaming, spamming, and sending emoticons. These behaviors may or may not be acceptable, desirable, appropriate, or even legal.

Surfing refers to navigating the World Wide Web. Lurking refers to the activity of someone who looks in on conversations without responding online. Spoofing is the act of posing online as someone else and then e-mailing a victim. Sexting, a combination of the words "sex" and "text messaging," refers to sending sexually provocative messages or visual images. Griefing refers to actions that are meant to deliberately cause annoyance. Raging refers to actions of a player that are caused by anger. Similar to raging, trolling refers to sending offensive or superfluous posts and messages to intentionally provoke a response. Flaming, also known as bashing, is a hostile and insulting interaction between Internet users. Spamming is when one person or company sends an unwanted e-mail to another person. Emoticons are also widely used in online communication. They are is a pictorial representations of a facial expression using punctuation marks and letters to express a person's mood.

Though there are great differences, online behavior is related to real-world habits (Singleton, 2010). On-line behavior is influenced by diverse factors, such as price differentials between online and offline channels (Devaraj, Fan, & Kohli, 2002), participation costs (Chen & Hitt, 2002), age, gender, and culture.

Ethics is a critical concern for online behavior, as well as off-line. There are many important ethical issues related with online behavior. Johnson (1997) identifies three general principles which should shape social behavior online:

- Knowing and following the rules of communication
- Respecting the privacy and property rights of others
- Comporting oneself in a polite and mannerly fashion

Many research methods can be used to study the dynamics of on-line behavior. For example, computer-mediated discourse analysis is one effective approach (Herring, 2004). Behavior researchers can track data on on-line behavioral phenomena through analyses of Instant Messaging (IM), social networking, and other social media (Gosling & Johnson, 2010). However, in teaching and learning studies, many find that the impact of on-line behavior on cognitive development is very complicated (Dawley, 2007; Preece, Nonnecke, & Andrews, 2004; Johnson, Code, & Zaparyniuk, 2007), and yet determining how to improve the experience of learners in cyberspace is key to normalizing on-line learning behavior. For design and development practitioners, efforts should be made to use these research findings to enhance the experiences of learners in online community environments. This is a large challenge for instructional technology professionals.

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On-line Learning
SEE DISTANCE EDUCATION AND LEARNING

Open Courseware
SEE INTELLECTUAL PROPERTY

Open Education
SEE ALSO DISCOVERY LEARNING and DISTANCE EDUCATION AND LEARNING and INDIVIDUALIZED INSTRUCTION and LEARNER-CENTERED INSTRUCTION and SELF-DIRECTED LEARNING

Open education is a loose and broad concept encompassing formal and nonformal study at all levels of education, sharing the common elements of being learner-centered and flexible as to methods of learning.

In the USA, open education is most often used to describe a set of elementary school practices that were inspired by reforms in British primary education based on the Plowden Report (1967). These reforms aimed to create school environments more congenial to the active, discovery type learning processes inferred from Piaget's theory of cognitive development. The American adaptation tended to feature open-plan architecture, multiage grouping, and team teaching—all aimed toward promoting individual progress in active learning settings (Giaconia, 1985). Walberg and Thomas (1972) identified a more specific set of features: flexible grouping, respect for learners, diagnosis of individual needs, instruction based on diagnoses, evaluation by extensive records of child's work, and a warm and child-centered climate.

In the UK and Canada, open education more often refers collectively to institutions that endeavor to provide postsecondary and adult education in a manner that is less restrictive than traditional colleges. Institutions that call themselves "open" are more accessible, admitting students regardless of formal qualifications; they enable students to study at times and places most convenient to them; and they reduce costs to students as much as possible (Paul, 1993). Because students usually want some sort of credential or certification of their educational attainment, open schools and universities conduct examinations for that purpose. Many emphasize a "competency-based" approach, which allows students to obtain credit on the basis of passing a competency test with or without formal study.

Open education is not synonymous with distance education. The latter refers to programs in which teachers and learners are separated in place and possibly in time and where didactic resources replace the traditional classroom interchange. Open education programs nowadays usually entail a large component of distance study, but they may also include face-to-face classroom instruction—although those classrooms may be located outside of a campus and may meet at unconventional times.

The term "open learning" has been proposed as an umbrella term to encompass all programs, distance or face-to-face, that broaden opportunities for learning by reducing barriers to access, that incorporate a range of teaching-learning strategies, and that allow flexibility of time and place (Rowntree, 1992; Kember, 1995).

All forms of open education depend on educational technology to provide the means for flexible learning—alternatives to teacher-led instruction—in the form of self-instructional packages, Web tutorials, and the like. Advances in technology, especially in digital transmission of audio and visual materials, have expanded the possibilities of open education exponentially.

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Open Educational Resources

Open educational resources (OER) are digital materials that are prepared and licensed in a way that allows their use for instruction and research more freely than under traditional copyright restrictions. These resources include software tools, educational content, and administrative support. Software tools support the design and delivery of content, the organization of content, including searching, and the operation of learning management systems. Educational content includes learning objects—text, visual, and animated, self-instructional modules, whole lessons, whole courses, and other collections of materials (Atkins, Brown, & Hammond, 2008).

While the nature of these digital materials is highly variable, the key is that they are freely and openly available for teaching, learning, and research (Hylen, 2007).

Downes (2011) states that what makes OER distinct are the supported functions rather than any characteristic of a particular resource. These functions include the ability to access, use, modify, and share the resource.

Caswell, Hension, Jensen, and Wiley (2008) describe the growth of the Open Courseware (OCW) Consortium as an OER success story. In 2007, this consortium consisted of 28 universities and more than 1,800 courses. According to the OCW Consortium Web site, by 2012 there were hundreds of participating institutions and thousands of resources. Despite this growth, Wiley and Hilton (2012) believe that OER have not yet reached their previously anticipated impact on K-12 education. They cite the slow and bureaucratic textbook selection process as a primary problem and note the relative lack of empirical research showing measurable benefits.

UNESCO, through its International Institute of Educational Planning, has given international support, viewing OER as a means of promoting access, equity and quality in education. The 2012 OER World Congress met in Paris at UNESCO headquarters and issued a declaration of support for OER. This declaration reinforced previous statements asserting education as a human right and called for all participating states to encourage more research, greater access, and adoption of OER.

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Open-Ended Assessment
SEE ASSESSMENT

Open Learning
SEE OPEN EDUCATION

Open Source Software
SEE OPEN EDUCATION RESOURCES

Open Universities
SEE OPEN EDEUCATION

Organizational Analysis
SEE ANALYSIS

Organizational Change
SEE ALSO CHANGE and CHANGE MODELS and PERFORMANCE IMPROVEMENT

Change happens in individuals, organizations and society. Various factors (i.e., globalization, workplace diversity, technology, social and economic factors, etc.) (Robbins & Judge, 2010) may cause organizations to transform from a current state to a new, optimal state (U.S. Legal, Inc., 2012) to improve performance, productivity, etc. (Brown, 2011). With change comes a natural resistance to change—from the organization itself and its members (Robbins & Judge, 2010).

Organizational change is linked to organizational development and often described as planned and managed change (Brown, 2011; Spector, 2012). Planned change occurs when a need for change is recognized, initiated, implemented and managed with involvement of people at various organizational levels. Transformational change occurs as a response to major changes in an organization's environment that require radical modifications to an organization's vision, strategy, processes and/or culture. Continuous change extends transformational change by which strategy setting, organization development, and implementing change becomes a constant, dynamic process (Cummings & Worley, 2008).

Individuals implementing and managing change are known as change agents. Change agents can be internal or external consultants to the organization (Spector, 2012) depending on the change's magnitude (Robbins & Judge, 2010).

Common approaches to planning and managing change include: Lewin's Three-Step model, Kotter's Eight-Step plan, Action Research and Positive model (Cummings & Worley, 2008; Robbins & Judge, 2010). Lewin's Three-Step model, one of the earliest, identified two main forces in organizations: those attempting to maintain status quo (Restraining forces) and those attempting to push for change (Driving forces) (Cummings & Worley, 2008; Robbins & Judge, 2010). If both forces are equal, then organizational norms and behaviors are maintained or in a state of "quasi-stationary equilibrium" (Cummings &Worley, p. 23). Successful organizational change occurs in three steps: Unfreezing, reducing forces maintaining the status quo; Moving, shifting the organization to a new level; and Refreezing, putting the organization in a new state of equilibrium for a sustained period of time. Change occurs when either *Driving forces* increase or *Restraining forces* decrease. Decreasing Restraining forces is an effective strategy because there is less tension and resistance (Cummings & Worley, 2008). Robbins and Judge (2010) offer a third alternative of combining both approaches.

Kotter's Eight-Step plan, based on Lewin's model, was developed to overcome problems when initiating change. Sequential steps include: (1) establish a sense of urgency, (2) form a guiding coalition, (3) create a new vision and strategy, (4) communicate new vision (similar to Unfreezing), (5) empower on a broad-base for others to act, (6) develop short-term wins (similar to Moving), (7) consolidate improvements, reassess and adjust change in organization, and (8) reinforce and anchor changes in organizational culture. (Cummings & Worley, 2008; Robbins & Judge, 2010).

In Action Research, change is a cyclical process in which initial research provides information to guide action, followed by evaluation to gain further information for new actions, and so on. It allows for change agents and clients to be co-learners in the process. Its main steps include: (a) problem identification, (b) consultation with a behavioral science expert, (c) data gathering and preliminary diagnosis, (d) feedback to a key client or group, (e) joint diagnosis of the problem, (f) joint action planning, (g) action, and (h) data gathering after action. Action Research continues to be a major approach (Cummings & Worley, 2008).

The Positive model is relatively new and based on Appreciative Inquiry (Cummings & Worley, 2008; Robbins & Judge, 2010). It departs from other change models because the focus is on what organizations do well or correct. Its purpose is to identify the organization's strengths and unique features on which changes are built. Through shared meaning and acceptance by its members, positive change can be planned and managed.

Organizational change is based on industrial/organizational psychology (Spector, 2012), is associated with fields of organizational development, human resource development/management (Burke, 2001), and human performance technology (Stolovitch, Keeps, & Rodrigue, 1999).

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Orienting Context

SEE CONTEXT

P

Part-Task Practice
SEE PRACTICE

Pattern
SEE VISUAL MESSAGE DESIGN

Pedagogical Agent
SEE AGENT

Pedagogy
SEE ALSO TECHNOLOGICAL PEDIGOGICAL CONTENT KNOWLEDGE

The word "pedagogy" originates from the Greek word that means to lead a child. Teachers lead their students by constructing and delivering curriculum. Curriculum embodies the knowledge and skills that a student must learn and how that learning will be assessed and evaluate. Myers (2003) discusses the pedagogy of sentence structure, while Webb (2002) explores the pedagogy of information, computers and technology topics. We can see that pedagogies could be different for different topics to learn.

Recent literature discusses a pedagogy to teach technology. Harris, Mishra, and Koehler, (2009) and Schmidt, Baran, Thompson, Mishra, Koehler, and Shin (2009) discuss the blend of how to differently teach various topics using different strategies and technologies. TPCK is the acronym that represents the study of technological pedagogical content knowledge. Reflecting the early work of Lee Schulman, Harris, Mishra, and Koehler (2009) conclude that a teacher's knowledge of pedagogy grows over time. The domains of this knowledge involve areas of how students learn, how to create and deliver instructional strategies and how to assess student acquisition of knowledge.

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Perceptual Modality
SEE ALSO VISUAL COMPETENCY

Perceptual modality is a model of a sense's physical structures as well as the information from that sense which is presented to the brain. Each sense has its own modality, which includes a range of anatomical, neurological, and symbolic structures and activities.

J. J. Gibson (1966) in his seminal work considers perception as sensory systems. The visual system, the auditory system, and the kinesthetic system each present a different informational environment to the brain. Howard Gardner (1993) establishes the term "multiple intelligences". This broadens the basis for research into a series of sensory modalities, as opposed to the previously held paradigm of an overall intelligence quotient. He establishes a basis for an individual's different learning styles grounded in their particular sensory range.

Sensory modalities have symbol-bearing abilities. After detailing the specific qualities of each sense's particular type of information, an assessment of the nature of the symbolic functions by sense can be explained. The symbolic components of perception can be shaped by cultural assumptions of the individual and the system used to analyze the perception. For instance, De Saussure (1915/1959) explains the different words used in different cultures to describe a tree. Each word relates differently to the world around it, demonstrating the capacity for conveying symbolic meaning through the senses.

Perception modalities can be used to analyze the efficacy of different learning strategies. For instance, Cockerline and Yearwood's (2009) work evaluates perceptual modalities in relation to Web-based learning. McCurry's (1996) Delphi study examines the differing modalities and learning materials for marketing education. For an overview of research on perceptual modalities, the Web site from the University of Oxford gives a yearly summary of publications. (See Additional Resources).

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Also See Additional Resources for Further Information on this Subject

Performance Analysis
SEE ANALYSIS

Performance Context
SEE CONTEXT

Performance Improvement
SEE ALSO COMPETENCY MODELING AND DEVELOPMENT and CONTEXT and ELECTRONIC PERFORMANCE SUPPORT SYSTEM and FEEDBACK and LEARNING ORGANIZATION and ORGANIZATIONAL CHANGE

The term “performance improvement” (PI) is viewed by many in the field to be synonymous with the phrase “human performance technology” (HPT). However, some prefer the term “performance improvement” over HPT because PI is focused on outcomes rather than on tools. (See Stolovitch, 2007 for a further discussion of these terms.) PI is concerned with measurable performance and how to structure elements within a results-oriented system (Stolovitch & Keeps, 1999). PI is used to improve the performance of organizations, processes and individuals (Rummler & Brache, 1995). It expands instructional design (ID) by employing the systems approach to address performance opportunities and problems.

Several models have been developed to address how to improve the performance of organizations, processes and individuals. The most comprehensive model of PI was originally generated by Deterline and Rosenburg (1992) and has been adopted by the International Society for Performance Improvement (ISPI). According to Stolovitch (2007, p. 142) it "has probably had the most global exposure" of any performance improvement model. It includes five interrelated components—performance analysis, cause analysis, intervention selection, design and development, implementation and change management, and evaluation (Van Tiem, Moseley & Dessinger, 2004).

One way of defining PI is to examine how those in the field view performance. According to Rosenberg, Coscarelli and Hutchison (1999), "There appears to be general agreement that HPT ultimately stems from the work of a number of behavioral psychologists" (p. 26). As a result, early approaches to performance improvement focused mainly on individuals and the processes they used to accomplish a task or job. Someone viewing PI this way is focused on subsystem performance (Swanson, 1999). While still concerned with individual accomplishment, PI is now focused on system-wide improvement—organizational performance is at the forefront of many in the field (Rummler & Brache, 1995; Swanson, 1999). Furthermore, newer frameworks that center on the socio-cultural aspects of performance improvement to include complex group and organizational structures have recently been introduced into the field (Schwen, Kalman, & Evans, 2006).

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Performance Measurement

SEE ASSESSMENT and COMPETENCY MODELING AND DEVELOPMENT and CRITERION-REFERENCED MEASUREMENT and e-PORTFOLIO and EVALUATION MODELS and PERFORMANCE IMPROVEMENT

Personal Digital Assistant

SEE MOBIL DEVICES AND FUNCTIONS

Personalized System of Instruction

SEE BEHAVIORISM

Perspective

SEE VISUAL MESSAGE DESIGN

Podcast

SEE TECHNOLOGICAL COMMUNICATION

Positive Reinforcement

SEE REINFORCEMENT

Post-Modernism

SEE SEMIOTICS

Practice

SEE ALSO COMPLEX LEARNING and EXPERTISE and REINFORCEMENT

Practice is an instructional tactic in which the learner performs repeatedly all or part of a specified skill. To be effective, practice is accompanied by feedback on the performance.

Most theories of instruction place a high value on practice, although for different reasons. Behaviorism posits that learners must exhibit some observable response in order to be provided with a reinforcer that will strengthen that behavior; a learning cycle consists of repeated responses followed by reinforcers delivered according to a schedule of reinforcement. Cognitive information processing (CIP) theory proposes that learners store new knowledge in long-term memory through provision of "extensive and variable practice" (Driscoll, 2005, p. 105). Since the primary tenet of constructivism is that learning requires complex, realistic, and relevant environments (Driscoll, 2005), practice should take the form of activity, preferably collaborative, within a problem-based environment.

The learning of attitudes can be facilitated through structured practice, according to Kamradt and Kamradt (1999); the key instructional tactic is evoking a response that exhibits a step toward the target attitude.

The domain in which practice is most clearly the dominant instructional tactic is psychomotor learning, ubiquitous in athletics, musical performance, and the workplace. Romiszowski (1999) proposes a sequence of five stages in the mastery of a new physical skill, requiring repetitive practice-and-feedback as the key instructional strategy.

According to the most authoritative recent summary of learning research, "One of the simplest rules is that *practice increases learning* [emphasis added] and there is a corresponding relationship between the amount of experience in a complex environment and the amount of structural change in the brain" (Bransford, Brown, & Cocking, 1999, paragraph 10).

A major issue in the use of practice is the question of whole-task or part-task practice. The answer is clearest in the physical skill domain. Here, simply repeating whole performances in a routine way does not lead to greater expertise. Rather, expertise develops through what Ericsson (2006) refers to as "deliberate practice":

> Deliberate practice presents performers with tasks that are initially outside their current realm of reliable performance, yet can be mastered within hours of practice by concentrating on critical aspects and by gradually refining performance through repetitions after feedback (p. 694).

Further, maintenance of high level skills requires constant repetitive drills on component skills, such as practicing free throws in basketball.

For highly complex learning tasks which may involve a combination of concepts, procedures, and even physical skills, whole-task practice is recommended. First, elaboration theory (Reigeluth, 2004) proposes a sequence beginning with performance of the simplest version of the whole task that is still fairly representative of the ultimate task; then the learner practices a more complex version of the task, and so on, until the desired level of complexity is reached. Second, cognitive load theory (CLT), besides supporting Reigeluth's method, proposes adding "scaffolds" to whole-task practice—performance supports that are embedded in the instructional system to give hints and coaching to the learner (van Merriënboer, Kirschner & Kester, 2003).

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Prerequisite Skills

SEE ALSO ANALYSIS and LEARNER CHARACTERISTICS AND TRAITS and LEARNING HEIRARCHY and SEQUENCING

Smith and Ragan (2005) define prerequisites as the "things a person needs to know or be able to do before a person is in a position to learn something else" (pp. 76–77). They further note that while some designers equate analysis of prerequisite skills with the development of highly structured, hierarchical instructional strategies, it is actually critical for all approaches, stating "constructing a model of the knowledge that goes into being able to achieve a goal makes for good instruction, no matter the strategy" (p. 77).

Entry competencies or entry characteristics are knowledge, skills and attitudes that learners must possess prior to the start of the instruction. Morrison, Ross, Kalman and Kemp (2011) note that analysis of these competencies is critical at two points in the design process. The first is during learner analysis, prior to the design of the instruction. Identification of prerequisites at this stage aids in determining at what level to begin the instruction. It also allows for identification of external supports that may be required to foster motivation and attitudinal readiness. Morrison et al. (2011) identify the second point in the design process where analysis of prerequisites is critical as the start of the instruction. They recommend using entry tests to determine if the individual learners do in fact possess the expected prerequisites. If one or more are below expectations they may be directed to complete a prerequisite course before continuing with the instruction.

Richey, Klein and Tracey (2011) define prerequisite skills as "knowledge and skills subordinate to the intended outcome of instruction that are expected to have been mastered prior to the given instructional event" (p. 193). This definition differs from those of Morrison et al. (2011) and Smith and Ragan (2005) in that it does not limit the focus to entry or pre-course knowledge and skills, recognizing that prerequisites exist on two levels; those that must be present at the beginning of the instruction and those that are developed within the course and must be mastered incrementally before the learner progresses to the next component. Individual unit or component level prerequisites that are developed within the structure of the course rely on careful, hierarchical sequencing of content to insure mastery of all prerequisites is attained prior to the start of instruction on the dependent content (Richey et al., 2011).

Prerequisite skills also impact content delivery strategies. Smith and Ragan (2005) note that students interpret instruction "based on the related content knowledge, values, beliefs and strategies that they already have available in long-term memory" (p. 129). Instructional designers facilitate this process through the stimulation of prerequisite knowledge as noted in Gagné's nine Events of Instruction. Richey et al. (2011) add that the goal of rehearsal, a key component of cognitive learning theory, "is to relate learners' prior experiences and knowledge (stored in long-term memory) with new information in working memory" (p. 59).

Identification of prerequisite skills aids the designer in determining what content should and should not be incorporated in the instruction. Prerequisite relationships between the knowledge and skills learned at various stages within the course affect content sequencing decisions. Additionally, identification and stimulation of prerequisite knowledge and skills within the course facilitates learning.

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Print Information Resources
SEE INFORMATION RESOURCES

Prior Experience
SEE LEARNER CHARACTERISTICS AND TRAITS

Prior Knowledge
SEE LEARNER CHARACTERISTICS AND TRAITS and PREREQUISITE SKILLS

Problem
SEE ALSO PROBLEM-BASED LEARNING and PROBLEM SOLVING STRATEGIES

Problems have two critical attributes. First, a problem is an unknown in some context. That is, there is a situation in which there is something that is unknown. According to Newell and Simon (1972), all problems have an initial state and a goal state that define the problem space. In order to solve the problem, people search the problem space for the most efficient path from initial to goal state. Second, finding or solving for the unknown must have some social, cultural, or intellectual value. That is, someone believes that it is worth finding the unknown. If no one perceives an unknown or a need to determine an unknown, there is no perceived problem. Finding the unknown is the process of problem solving.

Problems have several variable attributes. Foremost among these differences is the continuum between well-structured and ill-structured problems (Jonassen, 1997, 2000; Voss & Post, 1988). Most problems encountered in formal education are well-structured problems. Well-structured problems typically present all elements of the problem; engage a limited number of rules and principles that are organized in a predictive and prescriptive arrangement; possess correct, convergent answers; and have a preferred, prescribed solution processes.

Ill-structured problems, on the other hand, are the kinds of problems that are encountered in everyday practice. Ill-structured problems have many alternative solutions to problems, vaguely defined or unclear goals and constraints, multiple solution paths, and multiple criteria for evaluating solutions; so they are more difficult to solve. Learning to troubleshoot complex systems, learning how to make policy decisions, and learning to adapt accounting techniques are ill-structured problems.

Problems also vary in complexity. The complexity of a problem is a function of the breadth of knowledge required to solve the problem, the level of prior knowledge, the intricacy for the problem-solution procedures, and the relational complexity of the problem (number of relations that need to be processed in parallel during a problem solving process) (Jonassen & Hung, 2008). Ill-structured problems tend to be more complex; however, there are a number of highly complex well-structured problems, such as playing chess or writing computer programs.

Problems also vary along a continuum from static to dynamic. In static problems, such as those in textbooks, the elements and conditions of the problem do not change. In dynamic problems, the relationships among variables or factors often change over time. Changes in one factor may cause variable changes in other factors that often substantively changes the nature of the problem making dynamic problems more difficult. The more intricate these interactions, the more difficult it is to ascertain a solution. Ill-structured problems tend to be more dynamic than well-structured problems.

Based upon these variable characteristics, Jonassen (2000) identified eleven kinds of problems, including algorithms, story problems, rule-using problems, decision making, troubleshooting, diagnosis-solution problems, strategic performance, policy analysis problems, design problems, and dilemmas. The different kinds of problems vary primarily along the well-structured/ill-structured continuum.

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Problem Analysis
SEE ANALYSIS

Problem-Based Learning
SEE ALSO AUTHENTIC ACTIVITY and CONSTRUCTIVIST APPROACH and LEARNER-CENTERED INSTRUCTION and LEARNING BY DOING and PROBLEM and PROBLEM SOLVING STRATEGIES

Problem-based learning (PBL) is an approach to curriculum development, teaching and learning which situates people within authentic, complex and challenging problems representative of those found within a disciplinary field of practice.

Initially developed in the 1970s in the medical school at McMasters University in Canada, PBL was a pedagogical approach created to address students' inability to transfer knowledge gained through a lecture into clinical practice. PBL situated students directly within the complex, authentic problems required for competent medical clinical performance.

PBL has been relatively slow to find its way into K-12 education (Hung, Jonassen & Liu, 2008; Januszewski & Pearson, 1999). However, in the 1990s and now in the twenty-first century, findings from research on learning, calling for new approaches to curriculum, teaching and assessment (Bransford, Brown & Cocking, 2000; Sawyer, 2006; Schwartz & Fischer, 2003, 2006) have led to increased interest in PBL among educational researchers and practitioners.

Theoretically grounded in the constructivist theories of learning, PBL is an inquiry approach that develops deep understanding through engagement with complex, authentic ill-structured problems (Barrows & Tamblyn, 1980; Bereiter & Scaradmalia, 2010; Clifford & Friesen, 1993; Clifford & Marinucci, 2008; Darling-Hammond, et.al., 2008; Dumont, Istance, & Benavides, 2010; Friesen, 2009; Hmelo-Silver, 2004; Hung, Jonassen & Lui, 2008; Savery & Duffy, 1995; Scardamalia & Bereiter, 2003, 2006; Vardi & Ciccarelli, 2008). Within PBL, understanding is gained through engagement with problems, issues and questions (Darling-Hammond, et.al., 2007; Savery & Duffy, 1995).

Varied characteristics of PBL have been developed as it expanded to different disciplines and contexts. However, the following appear to span the various disciplines and contexts:

1. Ill-structured problems that require students to engage in multiple solution paths.
2. Learner-focused in that students develop knowledge on an as-needed basis as they progress towards solving the problem by deriving the key issues, defining their knowledge gaps, acquiring missing knowledge, building on the ideas of others, bringing forth evidence and taking collective responsibility for the overall advancement of knowledge.
3. Authenticity of the problem under study, embodied by alignment to the field of disciplinary and professional practice, and requirements that students work within the culture of the problem context.
4. Teaching as a participatory endeavor, seeing all participants as legitimate contributors to the knowledge advancements achieved by the group. (Barrows, 1985, 2002; Hmelo & Evensen, 2000; Hmelo-Silver & Barrows, 2006; Januszewski & Pearson, 1999; Hung, Jonassen & Lui, 2008; Scardamalia, 2001; Walker & Leary, 2009).

Evaluative research from 1970 through 1992 comparing PBL with more traditional methods of medical education found PBL to be significantly superior in building students' clinical performance (Vernon & Blake, 1993). Some critics of PBL suggest that it is a less effective strategy for novice learners, as it impacts heavily on cognitive load (Sweller, 2006). While, Hattie (2009) identifies PBL as one of education's disasters, it is important to remember that empirical studies within K-12 are scarce as PBL is a relative newcomer. A more recent meta-analysis indicated that PBL promoted learning across a number of contexts (Walker & Leary, 2009).

Perhaps it cannot be stressed enough, PBL is not merely the layering or the addition of problems onto conventional practice; rather, PBL requires new approaches to curriculum design, instruction and assessment.

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Problem Solving Strategies
SEE ALSO PROBLEM and SCHEMA THEORY

Traditional models of problem solving, known as phase models (e.g., Bransford & Stein, 1983) suggest that all problems can be solved if we: (1) identify the problem, (2) generate alternative solutions, (3) evaluate those solutions, (4) implement the chosen solution, and (5) evaluate the effectiveness of the solution. These processes involve a variety of strategies.

Problem solvers often apply domain neutral, generalizable strategies that may be used to solve any kind of problem. These are known as weak strategies. One example is means-ends analysis which involves reducing the discrepancy between the current state and the goal state of the problem by applying problem-solving operators. The problem solver isolates the goals to be achieved and then systematically selects the methods (means) to achieve each of those goals (Ernst & Newell, 1969).

Having isolated the goals, the solver selects the most important difference and then selects a means to reduce that discrepancy, proceeding to the next most important difference until a complete problem solution is developed. Means-end analysis is a recursive process that identifies discrepancies, which in turn requires planning to reduce that discrepancy.

Breaking a problem down into sub-problems is a generalized strategy that has been often recommended (Polson & Jeffries, 1985). In this strategy, the learner divides the problem into smaller sub-problems and then applies the decomposition process to the sub-problems until they are small enough to suggest an obvious solution. If the learner knows about a sub-goal state that can be reached in fewer steps, then the possible number of solution paths is reduced, making the problem easier to solve. Decomposition, like most of these general strategies, requires that the learners have complete knowledge of the techniques and problem solving domains.

The least structured and therefore weakest of the solution-generating methods is the generate-and-test method. Essentially, the problem solver brainstorms possible solutions that are then evaluated for their potential to solve the problem. This is perhaps the most common method for untrained problem solvers and relies on the general, intellectual abilities of the person generating the solutions.

Solvers who attempt to use *weak* strategies, such as means-ends analysis that can be applied across domains, generally fair no better than those who do not. Experts effectively use strong strategies, and some research has shown that less experienced solvers can also learn to use them (Singley & Anderson, 1989).

A variety of stronger problem solving strategies focus on understanding and applying domain knowledge, assuming that problem solving is a domain-specific process. Rumelhart and Ortony (1977) introduced the concept of schema as a form of knowledge structure used to identify type of problem being solved. Problem schemas include semantic information and situational information about the problem associated with the procedures for solving that type of problem. Strategies that focus learners' attention to the kind of problem that is being solved develop transferable problem solving skills.

Recalling a previously solved problem and applying that solution method to a current problem is a very natural step in problem solving, usually the first method that people use according to Polya (1957). When faced with a problem, we naturally ask ourselves if we have experienced a similar problem. Using analogical problems requires that learners recognize the similarity between the previous and current problems and that the learner can recall the solution method used in the previous problem. Reminding of previously solved problem is an example of case-based reasoning.

Analogical encoding is a strategy that involves mapping an analogous problem to the problem to be solved which requires emphasizing the structure of the analog to the structure of the problem independent of the surface objects in either (Gentner, 1983). Even though analogous problems may have different surface features, the higher-order, structural relations must be compared on a one-to-one basis between the source and target problems. Analogical encoding supports the induction of problem schemas.

Learners use many means to represent the problem to be solved. In science, equations are the most common. However, it is equally important to represent the problem qualitatively by constructing diagrammatic representations, such as concept maps, causal maps, free body diagrams, pictures and so on. Like analogical encoding, these methods support the induction of problem schemas.

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Procedural Learning

SEE GENERALITY

Procedural Scaffold

SEE SCAFFOLDING

Process-Oriented Instruction

SEE INSTRUCTION

Production

SEE ALSO DEVELOPMENT and INSTRUCTIONAL DESIGN and RAPID PROTOTYPING

In the instructional design process, “the term *production* refers to the application of creative arts and crafts to generate the actual materials used by learners” (Molenda & Boling, 2008, p. 81). Production activities are interwoven into the larger stage of development, “the process of translating the design specifications into physical form” (Seels & Richey, 1994, p. 35). The terms development and production are often used in tandem because, in fact, production tasks are done throughout this stage; it is a matter of focus when the emphasis shifts from function—the design, testing, and analysis of prototypes (development) to form—the creation of prototypes or a finished product (production).

Development and production often follow a strategy referred to as rapid prototyping (Tripp & Bichelmeyer, 1990). Rapid prototyping strategies initially generate the design of an envisioned form that would meet the specifications, and then development begins by producing low-fidelity prototypes that are tested, reworked, and retested. After this spiraling process of prototype testing and revision, the fidelity is increased either by an in-house production agency or by external sources. The output of the development and production stage is a final product or program that has been tested on the target audience, revised, and finally mass-produced for large-scale implementation. As the sorts of materials promoted by educational technologists have changed over the decades—from photographic and hand-drawn lantern slides, to short silent films, to live radio broadcasts, to sound films, to Web-based documents, to digital still and animated units, and to complex interactive simulations and games incorporating combinations of the above, one thing has not changed over the decades—the rectangular media image and the audio that sometimes accompanies it. In the 1900s the lantern slide had a resolution equal to a 20 megapixel camera, and the live orchestra or theater organist playing for a silent film exceeded CD quality audio, but what has changed are the techniques available to create them today. For instance, the techniques available to create color have grown exponentially in the last two decades, relying initially on colored pencils, paint, or chalk on paper or canvas, but now migrating to digital media that produce not just the 16 colors of the Apple 2E computer, but the millions of colors appearing on computers today. However, “more” or “digital” does not always equate with “better.” A blended watercolor wash on paper may produce a more appealing background than using a tool such as Photoshop where drop-down menus of each of the 16 million colors, myriad tools, and filters are available.

The solution to produce a successful finished product emerges within the dynamic dialogue between the instructional design specialist and the various technical craft specialists dealing, for example, with pacing, continuity, screen direction, and camera angles in the case of motion media (Mascelli, 1998). In the end, no amount of technical expertise or sophistication of tools can substitute for the creativity exercised by both the pedagogical specialists and the craft specialists in the production process.

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Professional Ethics
SEE ETHICS

Professional Standards
SEE ALSO COMPETENCY and ETHICS

Professional standards are developed and officially adopted by professional organizations (usually at the national level) to establish norms for the average practitioner. Professional standards include codes of conduct, general guidance in the performance of duties, and reflect the organizations' mission statements (National Science Teachers Association, 2010). These standards address professional knowledge (including education requirements), professional relationships (how practitioners conduct themselves with peers and students), and professional practice (what individuals in the field need to do and how to do it). The National Council for the Accreditation of Teacher Education, for example, evaluates teaching candidates as "Unacceptable" (inadequate understanding of the field), "Acceptable" (a general understand the field), or Target (a thorough understanding of the field) (NCATE, 2007).

Two sets of professional standards have particular relevance to educational technology: The International Society for Technology in Education (ISTE, 2011) for master's degree candidates who are certified in K-12 schools and the Association for Educational Communications and Technology (AECT) for candidates in higher education (Ed. D and Ph. D.) and industry. The AECT standards (AECT, 2007) reflect the organization's commitment to the individual (members "shall honestly represent the institution or organization with which that person is affiliated, and shall take adequate precautions to distinguish between personal and institutional or organizational views"); commitment to society (members "shall honestly represent the institution or organization with which that person is affiliated, and shall take adequate precautions to distinguish between personal and institutional or organizational views"); and commitment to the profession (members "shall strive continually to improve professional knowledge and skill and to make available to patrons and colleagues the benefit of that person's professional attainment").

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Programed Instruction

SEE ALSO BEHAVIORISM and FEEDBACK and INDIVIDUALIZED INSTRUCTION and REINFORCEMENT and SELF-DIRECTED LEARNING

Programed instruction is an instructional approach that came into prominence in the mid-1950s with the publication of several papers by B.F. Skinner (1954, 1958). Major features of the approach, as prescribed by Skinner, involved: (a) dividing instruction into very small steps or chunks of information (oftentimes just one or two sentences), called "frames", (b) requiring learners to respond to a question, usually of the fill-in-the-blank or short answer variety, after each frame, and (c) providing learners with immediate feedback, in the form of listing the correct response, after each frame. A key notion behind this instructional approach was that if learners who had the necessary prerequisite skills were provided with instruction in very small steps, (a) they would be likely to correctly respond to questions that assessed their ability to recall the knowledge, or apply the skill, that had just been presented to them, and (b) the feedback they received immediately after responding would positively reinforce them for answering correctly.

The instructional approach described above was referred to as "linear" programed instruction because all students were expected to proceed through the instruction in the same sequence, albeit with each doing so at their own pace (which was another key feature of programed instruction). However, other varieties of programed instructional materials also became popular during the 1950s, with the most popular of these alternative approaches being “intrinsic” (also called “branching”) programed instruction, which was initially proposed by Norman Crowder (1960). Branching programed instruction, like the linear variety, presented learners with instruction in steps, required them to respond to a question after each step, and then provided them with feedback. However, the size of the steps in branching materials were usually larger (e.g., oftentimes one or several paragraphs), the questions learners were asked were usually of the multiple choice variety, and the feedback learners received varied depending upon the response they made. This last feature was accomplished in print materials by directing learners to different pages depending upon which of the multiple choice responses they chose. Feedback under this type of programed instruction was intended to provide positive reinforcement to those learners who answered a question correctly and was intended to provide remedial instruction (often referred to as “instructional feedback”), and additional practice and feedback to those who answered incorrectly.

Programed instruction was most popular from the mid-1950s through the mid-1960s. During that period of time most programed instructional materials were presented either in print form or via “teaching machines”, which were mechanical devices that presented the instructional frames, questions and feedback to the students.

By the mid-1960s, enthusiasm for programed instructional materials was beginning to fade. As noted by Saettler (1990), one of the reasons for this diminishing enthusiasm was the lack of sufficient evidence that students who studied programed instructional materials were learning more than students who studied via traditional instructional methods. Moreover, students often reported that programed materials, especially those of the linear variety, were boring. Skinner (1986), in defending programed instruction, indicated that one of the prime reasons it was not more effective was that oftentimes those who developed programed instructional materials were not adhering to the principles of learning which were intended to underlie that instructional approach.

Today, although the term “programed instruction” is rarely used to describe instructional programs, several authors have noted that the primary components of programed instruction, in a modified form (e.g., instruction presented in larger steps), still form the basis for many current-day training programs in business and the military (Jaehning & Miller, 2007; Molenda, 2008).

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Project-Based Learning
SEE ALSO COLLABORATIVE LEARNING and LEARNER-CENTERED INSTRUCTION and LEARNING BY DOING

Project-based learning is a comprehensive and dynamic instructional approach in which students (through exploration, collaboration and the use of cognitive tools such as computer-based laboratories, hypermedia, graphing applications, and telecommunications) attempt to answer a driving question based on real-world problems so that knowledge can be shared and distributed among the members of the learning community (Blumenfeld, et al.,1991; Bransford & Stein, 1993). Project-based instruction differs from traditional inquiry by its emphasis on students' own artifact construction to represent what is being learned. Project-based instruction differs from inquiry-based activity by focusing on cooperative and collaborative learning. In project-based learning, students engage in an extended process of inquiry in response to a complex question, problem, or challenge. Collaborative projects allowing for student autonomy and decision-making are planned, facilitated and assessed by the instructor to help students learn key academic content. Twenty-first century skills such as collaboration, communication, problem solving, critical thinking, and the creation of high-quality, authentic products and presentations are characteristics of rigorous meaningful and effective project-based learning (Buck Institute for Education, 2012).

A federally funded experimental study of 7,000 twelfth grade students taught by 76 teachers in 66 high schools revealed that high school students scored higher on measures of problem-solving skills and their application to real-world economic challenges than students who received the more traditional instruction. Teachers also scored higher in satisfaction with teaching materials and methods than those in the control group (Finkelstein, Hanson, Huang, Hirschman, & Huang, 2010).

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Project Management

The term "project management" (PM) describes a range of activities that enable a project team to complete a project on time, on budget and in line with stakeholder expectations (Crawford & Pollack, 2007; van Rooij, 2010). Project management models range from the traditional models that focus on managing project deliverables, to iterative and collaborative models that recognize project management as wider ranging and more inclusive. These latter models, including agile or extreme project management, bring all of the stakeholders more fully into the structure of the model. The three main areas addressed by these latter models include the traditional management of deliverables, plus elements of team management, and robust communication between all stakeholders. Agile project management uses an iterative approach that is more suitable to the needs of dynamic projects such as those found in educational technology.

The management of deliverables has traditionally been considered the focus of project management as it consists of planning and monitoring the project with the aim of ensuring the project is completed as agreed to and on time. A number of tools and strategies have been developed to help with this process including PM software, visuals (e.g., GANTT charts) and decision making strategies (e.g., critical path analysis); the focus for these tools and strategies remains on timely delivery of product with less emphasis on team and communication.

Agile project management reflects the understanding that projects are undertaken by teams of individuals who must effectively work together to complete a project. A well functioning team helps to ensure the project will move forward smoothly. Terms such as "high performance team" are used to indicate when teams are functioning at peak performance levels. Well functioning teams consist of members who work well together, know what they are supposed to do at what time, and are able to do it.

Communication between all stakeholders is considered an essential process in the agile PM framework. Team members and clients need to know and understand the status of the project at any given point in time to ensure smooth functioning of the project. Communication enables an iterative process that helps to fine tune the project flow through smaller, more manageable adjustments to the project.

Bullen (2006) has suggested that managing academic projects (e.g., elearning projects) requires a project management strategy that is flexible enough to bridge the academic collegial culture and traditional project management culture. Doherty (2010) suggests that an agile project management style is best suited to meet the challenges articulated by Bullen (2010). Common practice amongst instructional designers also suggests a closer match with agile practices compared to traditional practices. A review of tasks commonly performed by instructional designers found that their work typically included project management, communication, and team supervision/collaboration/building (Kenny, Zhang, Schwier & Campbell, 2005).

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Prompting
SEE ALSO FEEDBACK and SCAFFOLDING

Prompting is a micro-level instructional strategy initially developed for the first level of Bloom's Taxonomy: Knowledge/Remember (Bloom, Engelhart, Furst, Hill & Krathwohl, 1956; Krathwohl, 2002) and later used for skill development (lower order and higher order).

In the first level of Bloom's Taxonomy, prompting can especially be identified in the drill and practice model of instruction for teaching invariant tasks (Reigeluth, 1999). There are two major degrees of memorization: recognition and recall; prompting is often used in both. It is utilized as one of the enrichment tactics for content that is difficult to remember, along with chunking, repetition and mnemonic.

Prompts are often equated with hints and cues. Doenau (1987) indicated that using cues and prompts is helpful for hinting at important information to foster recognition or recall or to help learners develop their understanding or skills. In addition, if learners are in their zone of proximal development (Vygotsky, 1978), they often need cues or prompts (or other kinds of scaffolding) to learn to perform at the required level (Huitt, Monetti & Hummel, 2009).

Prompting can often be utilized in the process of reflection (i.e., metacognition and sense-making) or evaluation, and it is generally coupled with feedback. For example, Davis (2003) investigated the effectiveness of generic and directed prompts on students' productive reflection in middle school science class. Also Kauffman, Ge, Xie and Chen (2008) investigated the use of prompting in a metacognitive way for promoting self-monitoring and problem-solving skills in college students. Prompts are seen as a way to spur reflection or self-evaluation as a type of elaborated feedback (i.e., provision of hints to prompt thinking about why a specific response was correct or not) and may allow the learner to review part of the instruction. Prompts should avoid providing the correct answer explicitly (Shute, 2008).

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Proprietary Software

SEE INTELLECTUAL PROPEERTY

Prototype

SEE RAPID PROTOTYPING

Public Domain

SEE INTELLECTUAL PROPEERTY

Push and Pull Messaging

SEE TECHNOLOGICAL COMMUNICATION

R

Rapid Prototyping

SEE ALSO PRODUCTION

Derived from the Greek *prototypon* meaning primitive form, and building upon the prefix *protos* and suffix *typos*, which literally means first impression, a prototype is an early or working model of a new design, a new system or a part of a system. A prototype can be used to communicate the experience that a new system will offer (Beyer & Holtzblatt, 1998). The design specifications of an interactive technology system can be prototyped using anything from a sketch of a screen, a storyboard, a complex piece of software, a cardboard mockup, a video simulation of a task, to a 3-D model of a workstation (Preece, Rogers & Sharp, 2007). Prototyping involves creating a limited version of the product for the purpose of answering specific questions about a design's feasibility, appropriateness and or functionality (Preece, Rogers & Sharp, 2007).

Prototypes are often used at various stages of the user-centered design process for user testing and continual improvement and refinement of computer interfaces, processes, products and systems prior to full-scale implementation, production or manufacturing. During the task, process or user analysis stage, the requirements of a new design are established. Designers build multiple mockups, or prototypes, of what an interface might look like using sketches, drawings or computer-supported layouts (Schneiderman, 2002; Schneiderman, Plaisant, Cohen, & Jacobs, 2010). Snyder (2003) describes a paper prototyping method used by well-known companies, like IBM and Microsoft, to brainstorm, design, create, test and communicate aspects of a user interface. Depending on the complexity of the system, an iterative series of prototypes are designed, built and tested with users to evaluate whether and how a design does what is required. Prototypes facilitate communication among members of the development team, as well as between the development team and the intended users (Snyder, 2003). Prototypes give a better impression of the user experience than a description can ever do (Preece, Rogers & Sharp, 2007).

Rapid prototyping can be defined conceptually as speedy, iterative development of design ideas and requirements into working models that can be tested with users to provide substantive feedback throughout the development process. The idea behind rapid prototyping is to save on time and costs by developing a working model that can be tested with users. The concept of a low-fidelity prototype was introduced by Nielsen (1993), who advocated for usability testing as a quick and economical approach to better user interface design. A low fidelity prototype reduces the features and level of functionality of the final system into a working model for testing with a few users (e.g., simplified algorithms, human operator behind the scenes, low fidelity media, uses fake data or content, paper mockups, or verbal scenarios). While it may not really resemble the final product, Preece, Rogers and Sharp (2007) defend the low-fidelity prototype as a useful proof-of-concept method that is simple, cheap and quick to produce. In contrast, a high fidelity prototype is more expensive to develop, is fully interactive, and includes more features and functionality of the final system in a working model for field-testing or implementation (e.g., complex algorithms, high fidelity media, authentic data and content, real work scenarios, marketing and sales tool) (Preece, Rogers & Sharp, 2007).

The prototyping process brings users into the design process and thus changes the design process. User data and continuous feedback provides an opportunity for designers and users to codesign systems. The goal of using prototyping as part of the user-centered design process is continuous iteration, improvement and extension of the design (Beyer & Holtzblatt, 1998; Nielsen, 1993).

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Really Simple Syndication

SEE ALSO BLOG and CLOUD COMPUTING

Really simple syndication (RSS) can be defined as both a method and standard for accessing content on the Internet. When RSS was first created in 1997, it was defined as a technology "used to push out blog updates" and "create custom Netscape home pages with regularly updated data flows" (O'Reilly, 2005, p. 3). RSS uses

Extensible Markup Language (XML) technology to deliver content from author to reader/audience (Beldarrain, 2006). The reader/audience subscribes to the author's RSS feed and receives new content as the content is updated and published.

Since 1997, RSS has gone through a number of name changes. Besides Really Simple Syndication, RSS has been named RDF Site Summary, Rich Site Summary, and Real-time Simple Syndication (Glotzbach, Mordkovich, & Radwan, 2008). The definition of RSS was modified in 2003 with the creation of the RSS 2.0 standard/protocol. Dan Winer and Adam Curry are credited with using RSS to create RSS 2.0 and podcasting, a way to broadcast audio files to users' iPods (i.e., MP3 players) (Cebeci & Tekdal, 2006). Hendron (2008) defined RSS 2.0 as a "new format (that) enabled content creators to embed a multimedia attachment in the RSS newsfeed file that anyone could publish to a Web server" (p. 6). With the RSS 2.0 protocol, MP3 owners can subscribe to authors and have new audio files delivered on demand. Atom, an alternative protocol to RSS 2.0, provides similar capabilities to RSS 2.0, but there are other noticeable differences between Atom and RSS (see Rowse, 2006 for examples).

Aggregators are an important part of RSS. An aggregator is a "software application that collects RSS feeds and displays them" (Martindale & Wiley, 2005, p. 56). The key feature is the "ability to collect RSS feeds from many different blogs and display the feeds in one convenient and coherent view" (p. 56). For example, a user that traditionally navigates too many different news Web sites during one Internet session could subscribe to all of the Web sites RSS feeds and have the content sent to only one page.

In education, researchers (Glotzbach et al., 2008; Maag, 2006; West, Wright, Gabbitas, & Graham, 2006) have studied how RSS changes the dynamic of interactions between teachers, students, and course content. Although RSS is thought of as useful (Glotzbach et al., 2008) and convenient (Maag, 2006) for students, West et al. (2006) identified several barriers to the adoption and use of RSS in courses. The barriers included instructors' lack of purpose for the use of RSS in a course (i.e., teaching first, technology second), students' lack of technical expertise with using RSS feeds and aggregators, and students' lack of understanding of how and why to use RSS feeds in future practice (West et al., 2006).

Today, RSS has been forecast as a tool that will "decentralize (the) settings of today's e-educational systems" (Kim, 2008, p. 1344). Combined with cloud computing, RSS could have the potential to further revolutionize the way we subscribe to content using syncing across our many RSS aggregators and devices.

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Real-Time Strategy Games

SEE DIGITAL GAME-BASED LEARNING

Rehearsal

SEE COGNITIVE STRATEGIES and PRACTICE

Reinforcement

SEE ALSO BEHAVIORISM and FEEDBACK and PRACTICE and PROGRAMED INSTRUCTION

In the perspective of the behaviorist school of psychology, reinforcement is the process of increasing some dimension of behavior—such as its frequency (e.g., playing chess more often), its duration (e.g., persistently trying to solve a crossword puzzle), its magnitude (e.g., striking a punching bag harder), or its latency (e.g., doing any of the above more quickly following a cue)—by delivering an appropriate reinforcer immediately after the behavior.

This concept is at the heart of operant conditioning, which proposes that behaviors that are reinforced will tend to be strengthened (in frequency, duration, magnitude, or latency) while those that are not reinforced will weaken. In the words of B.F. Skinner (1953), the most prominent proponent of this theory, "In operant conditioning we 'strengthen' an operant in the sense of making a response more probable or, in actual fact, more frequent." (p. 65). There has been much debate and experimental research around the question of what is a reinforcer, how to classify different types of reinforcers, and how to effectively employ reinforcers in learning environments (Driscoll, 2005). What behaviorists agree upon is that any sort of stimulus—any object (such as food), any activity (such as a smile)—may be classified as a reinforcer only to the extent that it increases the strength of the behavior that preceded it. If it works, it's a reinforcer; if it doesn't it's not.

Reinforcement theory was the reigning theory of learning in the world of educational technology in the 1960s. Skinner (1968) had demonstrated the feasibility of incorporating the principles of reinforcement into teaching machines, devices that required learners to make a response (e.g., writing an answer or pushing a button) and receive feedback in order to proceed. For some types of learning tasks the response-reinforcement chain could be embedded in a book format, known as programed instruction. He called this design methodology the "technology of teaching" (1965), and others followed his lead. Indeed, probably the first book to be entitled "educational technology" (DeCecco, 1964) was an anthology of papers on programed instruction.

During the 1960s the research focus of what had been the audiovisual education field shifted sharply toward work on teaching machines and programed instruction, prompting the change of the name of the field to educational technology. Torkelson (1977) analyzed the contents of *AV Communication Review* (predecessor to *Educational Technology Research and Development*) and found that between 1963 and 1967 these topics represented a plurality of all articles published.

In more recent years cognitively oriented perspectives on teaching and learning have gained greater prominence, in part to deal with the reductionist tendencies of behaviorist methods. Contemporary instructional designers now seek, according to Tennyson (2010), "instructional theories that emphasize synthesis and integration of sets of knowledge and skills" (pp. 13–14). Still, the 1960s quest to embed response and reinforcement within learning environments sparked the revolutionary turn toward active, participative, individualized learning systems that now characterize the field of educational technology.

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Repetition
SEE ALSO COGNITIVE STRATEGIES

Repetition is a micro-level instructional strategy associated with the first level of Bloom's Taxonomy, Knowledge/Remember (Bloom, Engelhart, Furst, Hill & Krathwohl, 1956; Krathwohl, 2002). It refers to a practice that involves recurrence of certain information or actions, which aids memorization. van Merrienboer and Pass (2003) also note that repetition is an instructional method mainly related to schema automation through stimulation of compilation (combining parts of a task into a single performance) and strengthening (making the cognitive links among parts of a task stronger).

On one hand, repetition is generally utilized for accomplishing invariant tasks, which require memorizing factual information or routine procedures. No understanding is involved in accomplishing invariant tasks, nor do they typically require learning how to deal with variation. They require "rote" learning, as Ausubel (1968) referred to it. Even though it has a bad reputation in the field, rote memorization is sometimes important in that higher forms of learning are often not possible without some memorization (Reigeluth, 1999).

On the other hand, repetition can be utilized for learning complex skills as well. In his explanation of the part-task approach for learning complex skills, van Merrienboer (2003) emphasized the importance of repetition of part tasks.

Repetition can also be characterized by its purpose of use. Craik and Lockhart (1972) once identified two types of repetition: maintenance and elaboration. Maintenance repetition refers to the repetition of an event not attempting to process it at a deeper level such as repeating new foreign vocabulary terms. However, elaboration repetition seeks to promote deeper processing by providing redundant information with new information. Typically relevant and familiar information is repeated to enhance or modify propositions in short term memory to link with already encoded knowledge.

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Research Ethics
SEE ETHICS

Resource-Based Learning
SEE INFORMATION RESOURCES

Rich Media
SEE ALSO MEDIA and TECHNOLOGY-ENABLED LEARNING

Media richness theory provides a framework to assess the ability of a particular media to reducing uncertainty and equivocality of the message presented (Daft & Lengel, 1984). Uncertainty occurs due to a discrepancy in the amount of information required to accomplish a certain task while equivocality results through differing interpretations regarding the situation in which the information is to be used. The primary use of rich media is to address the equivocality in a given situation.

Equivocality may be seen as ambiguity and is addressed through the level of media richness. Based on the original work of Daft and Lengel (1984; 1986) a hierarchy was established for ranking media richness. The criteria for the hierarchy are "(a) the availability of instant feedback; (b) the capacity of the medium to transmit multiple cues such as body language, voice tone, and inflection; (c) the use of natural language; and (d) the personal focus of the medium" (Banerji & Ghosh, 2010, p. 281). Based on this theory, media may be ranked hierarchically: face-to-face communication is the richest medium while static text is the least rich. Richer media may facilitate more accurate and meaningful transmission and exchange of ideas where ambiguity is present (Havard, Du, & Xu, 2008). Havice, Davis, Foxx, and Havice (2010) define rich media as "blending of text, audio, video, and dynamic motion" (p. 54).

Messages with the potential for higher ambiguity generally require rich media while messages with little or no ambiguity may only require lean media. Liu, Liao, and Pratt (2009) found that learner concentration can be effected by the richness of a particular media noting that media composed of streaming audio-text-video maintained higher levels of concentration when compared to audio-text and audio-video in a software development course. The level of concentration also had a positive correlation to users' acceptance and intention to use the technology. In this case, given the detailed nature of the message (course content), the appropriate choice was rich media. In a course where the message has less ambiguity, lean media may be a more appropriate choice.

Lean media are also effective for learning; it is the potential ambiguity of the message that drives the decision as to the level of richness required. The use of rich media does not always equate to a better understanding of the content to be learned. Du, Hao, Kwok, & Wagner (2010), studied students' use of PDAs for course quizzes and exercises, and for communication with the instructor and fellow students. PDAs, instant messaging, and phone texting have generally been referred to as lean media (Du et al., 2010). When compared to students not using the PDAs, students using PDAs attained better overall understanding and high course satisfaction. While the information and lectures were essentially the same for both groups, the use of the PDAs created a rich media environment for learning.

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Role Playing Games

SEE DIGITAL GAME-BASED LEARNING

Rote Learning

SEE REPETITION

RSS 2.0

SEE REALLY SIMPLE SYNDICATION

Rule of Thirds

SEE VISUAL MESSAGE DESIGN

S

Scaffolding

SEE ALSO COGNITIVE APPRENTICESHIP and COMPLEX LEARNING and PROMPTING

Scaffolding derives from the theory of cognitive apprenticeship that emphasizes the social context of learning and the interaction between experts and learners (Brown, Collins, & Duguid, 1989; Collins, Brown, & Newman, 1989) and has roots in Vygotsky's (1978) zone of proximal development concept. As an instructional strategy, scaffolding emphasizes providing temporary support for those task aspects that learners have difficulty performing. The support can take the form of suggestions or direct help. Guidelines, prompts, and feedback are essential for the design of scaffolding (Quintana et al., 2004). It can also offer guided inquiry support for learners to observe an expert's practices through visual step-by-step instruction, live demonstrations, or video/audio (Jonassen, Mayes, & McAlesse, 1993; Williams, 1992). Instructors can then monitor learners' learning progress and provide appropriate interventions or adjust the amount of scaffolding at critical times.

Traditionally, scaffolding is dynamically provided by the instructor. More recently, technology has enabled scaffolding to automate non-salient portions of tasks to reduce cognitive demands, model the organization of problem-solving activities, and facilitate collaboration among learners (Manlove, Lazonder, & de Jong, 2009; Quintana et al., 2004). Scaffolding also supports students' readiness for new learning or tasks and focuses their attention on task or problem elements of particular importance (Reiser, 2004).

Hannifin, Land, and Oliver (1999) suggested four different types of scaffolding strategies to support inquiry, reflection and self-regulation, modeling, and task completion. For example, a procedural scaffold may be a hyperlink through which learners can access further information or guidance to support task completion. Technology may thus provide a means through which students have immediate access to scaffolding (e.g., metacognitive prompts, critical problem-solving steps) to enhance their problem solving processing.

Scaffolding should be gradually decreased or faded (Collins, Brown, & Newman, 1989; McNeill, Lizotte, Krajcik, & Marx, 2006; Pea, 2004). This is to ensure that learners are able to perform needed activities or tasks by themselves without the help of the scaffolds.

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Schema Theory

SEE ALSO ADVANCE ORGANIZER and COGNITIVE DISSONANCE THEORY and COGNITIVE LEARNING THEORY and MEMORY

The term “schema” in contemporary psychology refers to an abstract mental construct that is a condensed representation of a subset of our interactions with the environment. The notion of such hypothetical knowledge structures has been considered by ancient and more contemporary philosophers, such as in Kant’s (1781/1990) categories, whereby experiences were understood by reference to something previously learned. However, schema origins in contemporary psychology are usually accredited to the British psychologist Sir Frederic Bartlett and the French child psychologist Jean Piaget.

Bartlett (1932) argued that rather than storing literal copies (viz. a complete snapshot) of all of the details of our experiences, we instead construct a mental representation, the schema. For Bartlett, learning was constructive and likewise memory was reconstructive rather than reproductive. That is, recall involves retrieving the schema, and then implicitly or explicitly regenerating the details if and when required.

Piaget (1926) theorized that children progress through various stages. Children develop schemas for understanding environmental experiences, and then these can change with further experiences in two ways. Sometimes the new experiences would be a mere supplement to the existing schema and thus assimilated, whereas at other times the new experiences required accommodation, that is, changing the schema. Intellectual growth requires the formation of the schemas, and also improvements in logical reasoning involving the utilization and interaction of the schemas. At the time, learning and memory was more commonly conceived as the formation of static associations between stimuli and responses which were later recalled automatically from environmental cues; therefore Bartlett’s and Piaget’s viewpoints were neglected for some years. However, the schema notion today is widespread in many disciplines (although labels may vary: scripts, plots, plans, themes, outlines, narratives, frames, frameworks, nodes, mental models, stereotypes, kernel, gist, concept maps, graphic organizers, and more), attesting to the utility of the general idea of a network of interacting mental structures representing environmental experiences.

Some of these variations have developed in the context of classroom instruction. For example, Ausubel (1960, 1968, 1978) introduced the idea of the “advance organizer” as a method to activate existing schemas and thus facilitate new learning, a process referred to as “subsumption theory.” Subsumption was said to be a feature of classroom learning, as opposed to rote laboratory learning, and it did not involve developing new cognitive structures, rather more the reorganization of existing structures and assimilating new content.

"Schema Theory" is a specific application developed by the educational psychologist Richard Anderson in the context of reading instruction. Anderson (1977, 1994) argued that reading comprehension and retention is a function of the reader's preexisting schemas or world knowledge. This approach generated considerable research, though it has slowed somewhat in recent years. The schema approach to reading has recently been reexamined by McVee, Dunsmore, and Gavelek (2005). They especially studied its inadequacy with regard to sociocultural approaches to literacy, including Vygotsky's (1986), a characterization that is not universally accepted (Krasny, Sadoski, & Paivio, 2007).

Controversial issues yet to be resolved have to do with the origins of schemas, as well as the extent to which they change and how, and also which classroom practices most effectively achieve the interaction of past and present learning, including how technological tools can enable this interaction.

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Also See Additional Resources for Further Information on this Subject

Screenager
SEE DIGITAL NATIVES AND IMMIGRANTS

Screen Design
SEE VISUAL MESSAGE DESIGN

Second Life
SEE VIRTUAL WORLDS

Self-Directed Learning
SEE ALSO INDIVIDUALIZED INSTRUCTION and LEARNER-CENTERED INSTRUCTION and OPEN EDUCATION and PROGRAMED INSTRUCTION and SELF-REGULATION

Self-directed learning can be viewed as a desired goal—a condition in which humans are empowered by selecting and achieving their own learning projects—and as an instructional technique in which learners pursue objectives with minimal guidance from an instructor.

The concept emerged from descriptive research by Tough (1971) that discovered that people in their everyday lives undertook an extraordinary number of informal learning projects, dozens of them totaling hundreds of hours per year. Malcolm Knowles (1975) popularized the term "self-directed learning" as part of his theory of andragogy, proposing that adults grow in their capacity and need to be self-directing in learning.

Knowles's humanistic ideal attracted adult educators, spawning a proliferation of literature cresting in the 1980s and then subsiding toward the early 2000s. Within adult education much of the literature was oriented toward the philosophical, seeing the purpose of self-directed learning to be leading the learner toward critical reflection and even emancipation (Mezirow, 1985; Merriam & Caffarella, 1999). Research focused not so much on effectiveness as on the characteristics of adult learners and determining an individual's readiness for greater control and responsibility for his or her own learning (Brookfield, 1985).

The timing of the theory coincided with a rapid expansion in the means of self-instruction. The programed instruction movement and the individualized instruction movement had each contributed new, effective formats, such as programed textbooks, learning stations, and self-instructional modules, both print and audiovisual. Self-directed learning advocates were able to draw on this installed base of software to implement new initiatives in formal education and corporate training. It is the design and use of resources for independent study that draw self-directed learning into the realm of educational technology.

The translation of self-directed learning into the corporate realm has had a more pragmatic basis. The impetus for all forms of self-instruction in corporate training came with the productivity movement of the 1980s and 1990s. The amount of time employees spent in training activities became a subject of intense scrutiny by analysts looking for ways to squeeze out inefficiencies. The emerging concept of self-directed learning allowed managers to propose cutbacks in group-based classroom training, shifting responsibility to employees to find time to study independently, perhaps even on their own time. Piskurich's (1993) guide to corporate applications defines self-directed learning as the latest manifestation of self-instructional packages, based on prespecified objectives and sequence of material—the antithesis of Knowles' original notion.

Currently, the issues associated with self-directed learning are played out primarily in the realm of distance education. As Garrison (2003, p. 165) cogently points out, there is an inherent philosophical tension between the cognitive autonomy and control that are central to self-directed learning and the "opportunities to test personal meaning and reconstruct social knowledge" that are central to a constructivist and collaborative view of the ideal learning environment.

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Self-Efficacy
SEE ALSO MOTIVATION

Self-efficacy, the belief in one's own capability to accomplish a task, is a psychological construct that is also referred to as "perceived self-efficacy." Self-efficacy describes an individual's belief or perceptions of how effectively he or she can execute an action. Perceived self-efficacy refers to a person's "expectations of personal mastery… [and] effectiveness" (Bandura, 1977; p. 193). It occurs in a "designed setting… [and] is a person-in-context construct" (Cervone, Mor, Orom, Shadel, & Scott, 2004, p. 190). Self-efficacy, perceived ability to complete a task, varies with the task. For example, a student may have high self-efficacy for solving algebra equations but low self-efficacy for playing bridge.

Perceived self-efficacy affects performance regardless of the underlying skill (Bandura, 1997). Media research suggests that students will put forth effort to complete a task if they understand the requirements and they have the requisite skills to learn the skill and "the skills to learn from this medium" (Clark & Sugrue, 2001, p. 83). The learner's self-efficacy for learning a specific skill and from a particular medium both affect a learner's motivation.

Diverse instructional strategies can differentially affect self-efficacy and performance. Students who receive feedback that tells them how to improve have greater self-efficacy and better performance than students who receive evaluations identifying norm-referenced strengths and weaknesses (Chan & Lam, 2010). In other words, a teacher's formative feedback can increase learner self-efficacy and performance.

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Self-Regulation
SEE ALSO COGNITIVE PROCESSES and METACOGNITION and MOTIVATION and SELF-DIRECTED LEARNING

Self-regulation (SR) definitions have revealed a progressively finer grain of SR processes over time. These definitions have expanded from including the active meta-cognitive, motivational, and behavioral self-processes to advance one's own learning (Zimmerman, 1989) to:

> …planning and managing time; attending to and concentrating on instruction; organizing, rehearsing and coding information; establishing productive work environment and using social resources effectively… it involves self-efficacy, outcome expectations, task interest or valuing, a learning goal orientation, and self-satisfaction with one's learning and performance (Zimmerman, 2004, p. 139–140).

Self-regulation refers to a learner's cognitive, behavioral, and emotional mechanisms for sustaining goal-directed behavior (Bembenutty, 2009). Therefore, self-regulation is not a unitary construct with one set of cognitive, metacognitive, motivational, and behavioral strategies (Kaplan, 2008). Learner self-regulation includes multiple activities for planning, implementing, monitoring, evaluating, and revising learning activities and strategies to accomplish predefined and explicit instructional goals. Efforts to substantiate self-regulation presuppose a detailed accounting of diverse components, "each represented by a variety of proxy variables which can be measured to establish the appropriate level at which the individual or group in question operates" (Cascallar, Boekaerts, & Costigan, 2006, p. 297).

The plethora of theoretical and operational definitions of self-regulation has not facilitated research progress and has led to a call for clear, consistent definitions explicitly linked to operational measures (Schunk, 2008). Self-report measures are adequate measures under some circumstances (Pintrich, Smith, Garcia, & McKeachie, 1993), but in others they may not be sufficient to operationally define self-regulation. For example, self-regulation has been broadly "defined as a multi-component, multi-level, iterative, self-steering process… in the service of one's goals which may be more appropriately investigated with domain specific measures" (Boekaerts, Maes, & Karoly, 2005, p. 150).

Self-regulation process measures may be essential to understand "the very dynamic process of self-regulation in learning" (Cascallar et al., 2006, p. 297). The Motivated Learning Strategies Questionnaire (Pintrich et al., 1993) is an example of a self-report measure with cognitive and metacognitive scales that has been adapted to measure domain, context specific self-regulation (Lee, Lim, & Grabowski, 2010). Self-regulation strategies have been measured with self-reports and with context-specific learner outcomes, such as the amount of learning and attrition levels (Sitzmann & Ely, 2010). Self-regulation processes also have been measured with computer evidence (Schraw, 2010), with software that records self-regulating interactions (Winne, 2010), and with other online trace methodologies that detect, trace, model, and foster students' SR processes (Azevedo, Moos, Johnson, & Chauncey, 2010).

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Semiotics
SEE ALSO COMMUNICATION and GRAPHICS

Semiotics (also semiology) is defined as the study of signs. Semiotics treats objects as texts to be read and interpreted. Semiotics concerns itself with how humans communicate beyond traditional linguistics through visuals, advertising, art, music, theatre, foods, and popular culture. Contemporary semiotics would add the Internet, twitter, and new communications technologies as significant sign systems. Semiotics stems from the twin founding models of Swiss linguist Ferdinand de Saussure (1857–1913) who preferred the term "semiology" and American philosopher Charles Saunders Peirce (1839–1914). Saussure (1916) perceived a sign as being divided into signifier and signified. Most simply, the signifier is the object and the signified the meaning. Peirce (1991) categorized the semiotic system into three components: object (sign), interpretant (signified), and representamen (signifier). Semiotics extended linguistics literally into any area of how signs operate, and includes issues of metaphor, codes, intertextuality, modes of address, denotation (dictionary meaning) and connotation (emotional meaning), text (open and closed), and paradigmatic/syntagmatic analyses.

Thomas Sebeok (1920–2001) extended semiotics into nonhuman communication systems (Sebeok, 1972). Umberto Eco (1932–) explored the semiotics of lying (among other issues) and used semiotics as the basis of his several novels, especially *The Name of the Rose* (Eco, 1983). Roland Barthes (1915–1980) focused on the semiotics of the image, especially advertising images, as well as myth and mythologies (Barthes, 1977).

The postmodern explorations of Jacques Derrida (1930–) and his introduction of the concepts of *difference* and *deconstruction* stemmed from Saussure's concepts of *langue* and *parole* (Derrida, 1997). The term "deconstruction" has moved into the popular realm and is often used (incorrectly) to simply mean analysis. In other directions, Eco (1994) extended this thought from reality to hyper-reality, while Baudrillard's (1991) writings on the concept of the simulacrum point to unique and sometimes troublesome directions.

Semiotics has always been a borderline consideration in the field of educational technology, though its foundational insights are clearly significant in the study of media and media codes. Semiotic terms like sign, symbol, icon, hyper-reality, and simulation/simulacrum commonly are used in educational technology literature.

Contemporary trends can be seen in the work of Danesi (2002) on the subject of media semiotics and Kress (2010) on multimodalities. Chandler (2002) summarized the basics of semiotics and included an examination of media, including television, film, the Internet, and multiple modalities.

Denis Hlynka

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Sensory Systems

SEE PERCEPTUAL MODALITY

Sequencing

SEE ALSO ELABORATION SEQUENCING and LEARNING HIERARCHY and MENTAL MODEL PROGRESSION and SIMPLIFYING CONDITIONS METHOD

Morrison, Ross, Kalman and Kemp (2011) define sequencing as “the efficient ordering of content in such a way as to help the learner achieve the objectives” (p. 136). Richey, Klein, and Tracey (2011) identify sequencing as “a major concern for instructional designers” and “one of the six domains of the instructional design knowledge base” (p. 78). Reigeluth (2007) adds that “sequence decisions are concerned with how to group and order the content” (p. 20) and that their importance is dependent upon two things, “the relationships among the topics and the size of the course of instruction” (p. 21).

There are numerous sequencing methodologies. Morrison et al. (2011) identify the most common approaches as Gagné’s hierarchical, prerequisite method, Posner and Strike's learning-related, world-related and content-related strategies and Reigeluth's elaboration theory-related method. Richey, Klein, and Tracey (2011) add Bruner's spiral curriculum to this list.

Hierarchical sequencing is the ordering of content based on the idea that each skill to be taught is made up of simpler, less complex "component skills" that must be mastered before the more complex skill can be learned (Reigeluth, 2007; Tennyson, 2010; Richey et al., 2011). Elaboration theory addresses sequencing based on the type of expertise the learner is expected to develop. Content expertise sequencing refers to the sequencing of knowledge-based instructional content and "arranges concepts according to superordinate, coordinate and subordinate relationships" (Morrison et al., 2011, p. 143). Task expertise sequencing refers to the sequencing of skill-based instructional content, directing the instructional designer to sequence content from the simplest to the most complex task (Morrison et al., 2011). Richey et al. (2011) note that the spiral curriculum method of content sequencing suggests "that curricula should be developed to address and build on basic ideas repeatedly until students grasp them fully" (p. 78).

Morrison et al. (2011) discuss three sequencing schemes originally proposed by Strike and Posner in 1976. Learning-related sequencing is based on the needs of the learner. It involves fives principles. When identifiable prerequisites exist, teach the prerequisite knowledge or skill first, sequence content from most to least familiar, present content from least to most difficult and most to least interesting, and "ensure that the learner has reached the appropriate development level before teaching a task or topic" (p. 140). World-related sequencing presents content in a manner that is consistent with the real world based on spatial, temporal, or physical attributes. Strike and Posner's third scheme, concept-related sequencing, includes four principles. When class relations exist, teach the characteristics of a class before the members of the class, present examples before propositions, move from concrete to abstract concepts, and teach "logical prerequisite concepts first" (Morrison et al., 2011, p. 140).

There is not one "right" approach to content sequencing. Sequencing decisions must be aligned with both instructional content and learner characteristics. Well-selected sequencing strategies minimize cognitive load and increase learning outcomes. Poorly selected, misaligned sequencing strategies do the opposite, increasing cognitive load and decreasing learning and transferability (Si & Kim, 2011).

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Serious Games
SEE DIGITAL GAME-BASED LEARNING and GAME DESIGN

Shading
SEE VISUAL MESSAGE DESIGN

Shape
SEE VISUAL MESSAGE DESIGN

Short Message Service
SEE MOBILE DEVICES AND FUNCTIONS

Sign
SEE SEMIOTICS

Simplifying Conditions Method
SEE ALSO ELABORATION SEQUENCING

The simplifying conditions method (SCM) is a macro-level instructional strategy, which is highly associated with Reigeluth's Elaboration Theory (Reigeluth, 1987, 1999). SCM is a sequencing approach that starts with the simplest real-world version of a complex task that is representative of the whole task, and then progresses to ever more complex versions of the task as each is mastered, until it reaches the desired level of complexity, much like most video games.

For learning a complex cognitive task SCM can help learners to understand the task holistically and even to attain the skills of an expert from the very first lesson or project. Since the learners work on a real-world version of the task, SCM is suitable for situated learning, problem-based learning, computer-based simulations, and so on (Reigeluth, 1999). SCM promotes the formation of a sound cognitive schema, which enables more complex understandings to be more easily acquired.

SCM proposes that tasks can be purely *procedural* (in which case experts think in terms of steps) or purely *heuristic* (in which case experts think primarily in terms of causal models, rules of thumb, and other heuristics) or *combinations* of procedural and heuristic on a continuum between those two extremes (Reigeluth, 1999).

The SCM for both procedural and heuristic tasks consists of two parts: epitomizing and elaboration (Reigeluth, 1999). Since the principles of epitomizing are based on holistic learning and schema building, epitomizing entails using: (1) a whole version of the task rather than a simpler component skill, (2) one of the simplest versions of the task rather than a complex one to avoid cognitive overload, (3) a real-world version of the task rather than a decontextualized version, and (4) a version that is fairly representative of the whole task. Similarly, the principles of elaboration are based on holistic learning and assimilation to schema, so each elaboration should be: (1) a different whole version of the task, (2) a more complex version of the task, (3) an authentic version of the task, and (4) a version that is fairly representative of the whole task (Reigeluth, 1999).

For procedural tasks, the simplest version of the task is usually the one with the fewest steps. The design of the sequence is primarily derived from the works of Scandura (1973) and Merrill (1980) regarding path analysis of a procedure (Reigeluth & Rodgers, 1980). Different paths of a procedure are used under different conditions, and the shortest path usually has the most simplifying conditions. If the shortest path is not very representative of the task, a slightly longer, more representative path is used. On the other hand, for heuristic tasks (Reigeluth, 1992), the simplest real-world version of the task is the one that requires learning the fewest heuristics. That version is identified by determining the conditions that distinguish simpler versions of the task from more complex versions.

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Simulation
SEE ALSO DIGITAL GAME-BASED LEARNING and EXPERT SYSTEMS

The use of simulations in education and training has a long and generally successful history in a broad spectrum of domains including business (Griffin & Williams, 1964; Mayer, Dale, Fraccastoro, & Moss, 2011; Pasin & Giroux, 2011), military science (Fletcher, 2009; Macedonia, 2002), medicine (McGahie, Siddal, Mazmaninan, & Myers, 2009; Scalese, Obeso, & Issenberg, 2008), traditional educational domains such as science (Rutten, van Jooligen, & van der Veen, 2012), as well as in specific applications such as pilot training (Koonce & Bramble, 1998). Gredler (2004) defines simulations as "evolving case studies of a particular social or physical reality" (p. 573), describing the goal of simulations as experiences that allow participants to "take a bonafide role, address the issues, threats, or problems arising in the simulation, and experience the effects of one's decisions" (p. 573). Referring specifically to computer-based simulations, de Jong and van Jooligen (1998) define these experiences as "a program that contains a model of a system (natural or artificial, e.g., equipment) or a process" (p. 180). Aldrich (2004) describes simulations as "a methodology for understanding the interrelationships among components of a system or process," and "learning occurs by studying the effects of change on one or more factors of the model" (p. 287). Gredler (2004) further distinguishes between two primary types of simulations: experiential simulations, in which the participant assumes a role in a simulated situation or environment and symbolic simulations, in which the participant interacts with a simulated system while manipulating variables within the system to observe the results. As an important part of the characteristics of simulations, Sauvé, Renaud, Kaufman, and Marquis (2007) focus on the fidelity of the system, the degree to which the simulation reflects reality, by describing a simulation as "a simplified, dynamic and precise representation of reality defined as a system" (p. 253).

A primary issue within the literature is the degree to which the terms "simulations" and "games" are used either synonymously or without careful explanation or definition (Sauvé et al., 2007). While acknowledging many ways in which these technologies may overlap, Gredler (2004) describes one simple important difference: that in a game the goal of the experience, for the participant at least, is to win.

In comparing the essential attributes of games and simulations, Sauvé et al. (2007) echoes this distinction by describing games as "fictitious, whimsical, or artificial situation in which players are put in a position of conflict" while a simulation "is not necessarily a conflict, a competition" (p. 253). Some scholars (DiPietro, Ferdig, Boyer, & Black, 2007; Rieber, 1996) argue that the distinction may begin in the set of characteristics described by Malone and Lepper (1987), that games add elements that encourage intrinsic motivation including fantasy, curiosity, challenge, and control. In addition, other emerging experiences, including virtual worlds and virtual environments (Dalgarno & Lee, 2010), highlight the fact that many of these related tools, when carefully implemented, may meld into larger experiences with characteristics (and possibly benefits) of each (Hofstede, Caluwe, & Peters, 2010; Warburton, 2009).

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Situated Cognition

SEE ALSO COGNITIVE APPRENTICESHIP and COMMUNITY OF PRACTICE and CONSTRUCTIVISM

Situated cognition describes learning that takes place in a particular time and place and is high contextualized (Neville, 2010). Because meaning is often socially constructed (Hung & Chen, 2001), situated learning takes place within a defined social environment. Knowledge does not exist by itself, apart from the situation in which it is studied. Rather the knowledge exists within a sociocultural construct. Hung and Chen (2001) further posit that people construct meaning within a social atmosphere. This community of practice will frame the construct of the knowledge and skills (Woolfolk, 2012). Communities of engineers, physicians, and architects practice within different environments. Each group will frame its knowledge differently, and Jonassen (2003) found that different groups will use a different set of constructs to solve problems differently.

Further, it is the very nature of the different environments that governs what is learned (Pella, 2011). For example, learning about shore erosion presents different situations for students along the coast in New Jersey compared to the learning by students in Western Pennsylvania. The coastal New Jersey students live within the environment they are studying, while the western Pennsylvania students may only occasionally visit a beach. Living within a situation will surely change the scope and sequence of the knowledge acquired.

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Smartphone
SEE MOBILE DEVICES AND FUNCTIONS

Social Computing
SEE ALSO BLOG and COMMUNICATION and COMMUNICATION MAPPING and SOCIAL MEDIA and TECHNOLOGICAL COMMLUNICATION and USER-GENRATED CONTENT and WEB 2.0

Building upon the fundamentally social nature of human beings, social computing can be defined generally as online social interaction supported by digital systems (Erickson, 2011). From a computer science perspective, social computing refers to the hardware and software systems that are designed to support gathering, representing, processing, using, and disseminating information that is distributed across social collectives (networks), such as teams, communities, organizations, and markets. The latest social computing technology can support groups in maintaining continuous communication (Norman, 2011).

The type and quality of online social computing/interaction supported by modern and current digital technology and networks is vast, and can range from exchanging email, instant messaging, blogging, contributing to folksonomies and social bookmarking, creating mashups, social networking, video blogging, to engagement and immersion in virtual worlds and online games and creating and contributing to wikis.

From a historical perspective, the seeds of social computing were planted in the 1960s with the recognition that computers were useful for communication and social interaction as well as computation (Erickson, 2011). Early examples of social computing include mailing lists, bulletin boards, Internet relay chat, and multi-user domains. Improvements in basic communications technology, such as increased processing speed, network bandwidth and connectivity, and the increased growth of the World Wide Web, tended to support online social interactions such as allowing people to display content on web pages and link to the web pages of others (Erickson, 2011).

Social computing achieved wide spread popularity and diffusion in the late 1990s and early 2000s when digital systems became capable of doing more than serving as platforms for sharing online content and conversation (Erickson, 2011). A key development in social computing has been the design of digital systems that process user generated content from social interactions to feed the results of that processing back into the system (Erickson, 2011). Early computer conferencing systems served as passive platforms that supported online conversations that were understood by humans. Modern social computing, on the other hand, is defined by digital systems that process user-generated content in order to use it for its own purposes. This often involves producing new functionality and value for their users (Erickson, 2011). Cited as examples of active social computing are Google's Pagerank, an algorithm that estimates the importance of a page by looking at the number of pages that point to it, and Amazon.com's approach to user-generated reviews and ratings of these reviews on a helpfulness scale (Erickson, 2011). Donald Norman (2011) predicts that designing technologies for social interaction and groups will be a major theme in this century.

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Social Constructivism
SEE CONSTRUCTIVISM

Social Media
SEE ALSO SOCIAL COMPUTING and TECHNOLOGICAL COMMUNICATION and USER-GENERATED CONTENT and WEB 2.0

Kaplan and Haenlein (2010) define social media as "a group of Internet-based applications that build on the ideological and technological foundations of Web 2.0, and that allow the creation and exchange of User Generated Content" (p. 61). Mackey and Jacobson (2011) add "social media environments are transient, collaborative, and free-flowing, requiring a comprehensive understanding of information to critically evaluate, share and produce content in multiple forms" (p. 62).

The first social media sites appeared in 1998 with the launch of Open Diary, an online daily diary community much like what is now referred to as a blog (Kaplan & Haenlein, 2010), and Six Degrees, the first true social networking site that "allowed users to create profiles, list their Friends and surf the Friends lists" (Boyd & Ellison, 2008, p. 214). Since that time social media capabilities have expanded significantly. Lightle (2010) notes that social media users can now change existing content, write new content, personalize learning and build online educational communities around common interests. Kaplan and Haenlein (2010) add that "new sites appear in cyberspace everyday" noting that any attempt to classify applications must take into account both existing applications and those "that may be forthcoming" (p. 61).

Defining social media is less complex than identifying and categorizing applications. Social media allow the user to be an active rather than passive participant in the online environment. They are dynamic rather than static (Kaplan & Haenlein, 2010; Lightle, 2010; Mackey & Jacobson, 2011). Baird and Fisher (2005) note social media are allowing teachers to implement more diverse instructional strategies and "address learning styles rooted in digital technologies" (p. 8). They add that "the convergence of social networking technologies and a new 'always on' pedagogy is rapidly changing the face of education" (p. 6).

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Social Networks

SEE SOCIAL COMPUTING

Societal Ethics

SEE ETHICS

Sociocultural Theory

SEE COLLABORATIVE LEARNING and CULTURAL HISTORICAL ACTIVITY THEORY

Sociohistorical Theory

SEE CULTURAL HISTORICAL ACTIVITY THEORY

Spoofing

SEE ON-LINE BEHAVIOR

Strategy Games

SEE DIGITAL GAME-BASED LEARNING

Stop Action Animation

SEE ANIMATION

Subsumptive Sequencing

SEE SEQUENCING

Summative Evaluation

SEE ASSESSMENT and EVALUATION and EVALUATION MODELS

Symbolic Perception
SEE PERCEPTUAL MODALITY

Symmetry
SEE VISUAL MESSAGE DESIGN

Symbols
SEE SEMIOTICS

Synchronous Communication
SEE INTERACTION

System Analysis
SEE ANALYSIS and SYSTEMS APPROACH

Systems Approach
SEE ALSO ANALYSIS and INSTRUCTIONAL DESIGN MODELS

The term "systems approach" is not unique to the field of instructional design and technology (IDT). In many disciplines, the early use of this term referred to a process of building discrete models and testing them via simulation (Putnam, 1964). Speaking of learning systems, Ryan (1975) saw the systems approach as being:

> …a scientific, systematic, and rational procedure for optimizing outcomes of an organization or structure, by implementing a set of related operations to study an existing system, solve problems, and develop new or modify existing systems (p. 121).

The systems approach served as a practical application of general systems theory and in many respects was similar to the traditional scientific method of problem solving.

The early systems approach literature in the IDT field identifies various steps or stages of the process. They can be summarized for the most part in terms of two processes—analysis and synthesis (Richey, Klein, & Tracey, 2011). Analysis has two distinct phases: (1) the identification of component parts and (2) the identification of the relationships between the parts and the whole system (Silvern, 1972).

Synthesis, on the other hand, involves the design of a new system so that the identified problem can be solved. This new design can be the result of either establishing new relationships between existing parts, or identifying new parts or processes. Scholars referred to synthesis in a number of ways. Banathy (1968) called it systems development. Kaufman (1970) saw synthesis as choosing and implementing a solution strategy, and then determining its effectiveness. Romiszowski (1981) called synthesis the design and development of a solution.

The systems approach formed the impetus for the construction of instructional design models in the late 1960s, later known as instructional systems design models.

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Task Analysis
SEE ANALYSIS

Task Management
SEE PROJECT MANAGEMENT

Task Management Software
SEE PROJECT MANAGEMENT

Taxonomy
SEE ALSO INFORMATION CLASSIFICATION

Taxonomy can be defined as "a mode of inquiry into a given subject field, involving the arrangement of objects or concepts into groups on the basis of their relationships … a systematic distinguishing, ordering, and naming of type groups within a subject field" (Greenbaum & Falcione, 1980). There are two ways to view taxonomies. The first approach suggests that their categories are fixed. The second orientation views groupings as subject to change since categories constantly evolve (Lyman, O'Brien, & McKern, 2002). Taxonomies in instructional design and technology are more likely to fall in the latter category since the knowledge and processes of the field change over time.

The construction of a taxonomy begins by observing the similarities and differences of objects and events (Melton, 1964). These observations lead to various groups and subgroups. When examining a taxonomy, it is possible to see overlap among the categories. Categories of data can be classified into a hierarchy to indicate their relationships (Russ-Eft, Bober, de la Teja, Foxon, & Koszalka, 2008). On the other hand, the taxonomy may not be hierarchical in nature (Sokol, 1974). As understandings of events develop, the taxonomy can change. Therefore, "a taxonomy reflects the stages of development of a science" (Melton, 1964, p. 328).

While their principle objective is to show the structure of similar objects and the relationships between groups of similar items (Sokol, 1974), taxonomies can serve more than one purpose. For example, the well-known Bloom (1956) taxonomy of educational objectives was originally developed to facilitate communication among educators. Greenbaum and Falcione's (1980) disciplinary taxonomy was constructed to consolidate research findings in the organizational communications field.

Furthermore, taxonomies can take many forms. Bloom's (1956) taxonomy is simply an outlined list. Carrier and Sales's (1987) taxonomy of computer-based instruction is a table which identifies general variables, their definitions, and sample elements. Caffarella and Fly's (1992) taxonomy of instructional technology research is a three-dimensional cube with cells highlighting the various parts of the field. Richey, Klein, and Tracey's (2011) taxonomy of the instructional design knowledge base consists of major elements, their related major classes, and related subclasses.

James D. Klein

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Technological Communication

SEE ALSO BLOG and COMMUNICATION and COMMUNICATION MAPPING and SOCIAL COMPUTING and SOCIAL MEDIA and WEB 2.0

Technological communication, or communication that is mediated by technology, supports information dissemination and interpersonal interaction across geographic and temporal boundaries. Various methods of technological communication have been used in both virtual work and online learning. These methods have expanded the concept of classroom, encouraging learners to interact with people outside of a regular class setting and to act as knowledge brokers between different communities (Dennen, in press). In practice, technological communication methods range from simple, text-based systems (e.g., instant messaging and discussion boards) to more complex and media rich ones (e.g., videoconferencing and 3D virtual worlds). Four main features differentiate types of technological communication: directionality of communication, synchronicity, type and number of channels, and initiation of communication.

Some technological communication tools are used strictly for unidirectional communication. Such uses (e.g., podcasts and vodcasts) are focused on information dissemination and fit with a transmission model of learning. However, many tools support more robust bidirectional and omnidirectional communication, which are critical to constructivist learning models (Mehlenbacher, 2010) as well as to collaborative work.

Synchronicity refers to the timing of communication. Technologies such as instant messaging, text messaging, and video conferencing support real-time interaction, whereas technologies such as discussion boards and blogs enable asynchronous interaction. Each tends to be most appropriate for different types of activities and tasks, with synchronous technologies fostering immediacy, planning, and brainstorming and asynchronous ones fostering depth and reflection (Hrastinski, 2008).

Different technologies may support audio, video, and text-based communication channels in any combination. Tools that enable synchronous multichannel—particularly text plus either audio or video—communication (e.g., web conferencing) can yield both main and backchannel threads. Backchannel communication often enhances largely unidirectional or dissemination-oriented main channel, providing a space for listeners to interact in real time.

Either a push or a pull process can initiate technological communication. Pull occurs when a user makes a direct request for information (e.g., accessing a discussion board). Push is the opposite; messages are sent directly to a user without a clear request being sent (e.g., text messages and instant messages).

Looking to the future, technological communication options to support learning, performance, and collaboration will likely be shaped by both the capabilities of new devices, especially mobile ones, and the development of new social software and

Web 2.0-based tools. Learners have been quick to adopt these tools, and so it is incumbent on instructors and researchers to keep apace (Greenhow, Robelia, & Hughes, 2009).

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Technological Pedagogical Content Knowledge
SEE ALSO PEDAGOGY

The Technological Pedagogical Content Knowledge (TPACK) framework provides an approach "to examine a type of knowledge that is evident in teachers' practice when they transform their own understanding of subject matter into instruction in which technology and pedagogies support students' understanding and knowledge creation" (Kinuthia, Brantley-Dia, & Clarke, 2010, p. 647). Initially, when computers came to schools, teachers were taught technical skills independent of the pedagogy or content (Graham et al., 2009). The development of TPACK is based on the recognition that "pedagogical uses of technology are strongly influenced by the content domains in which they are situated" (Graham et al., 2009, p. 70).

TPACK was introduced to education in 2006 and provides a theoretical framework for understanding teacher knowledge required for effective technology integration (Mishra & Koehler, 2006). TPACK, as noted by Koehler (2011), "attempts to identify the nature of knowledge required by teachers for technology integration in their teaching, while addressing the complex, multifaceted and situated nature of teacher knowledge" (p. 2).

Mishra and Koehler (2006) built upon Shulman's (1986) pedagogical content knowledge (PCK) framework. TPACK acknowledges the combination and interplay of three key forms of teacher knowledge: pedagogical (PK), content (CK), and technology (TK) (Koehler, 2011). The TPACK framework is composed of seven components:

- *Content Knowledge* (CK)—"knowledge about the actual subject matter that is to be learned or taught" (Koehler & Mishra, 2008, p. 13).

- *Pedagogical Knowledge* (PK)—"the process and practice or methods of teaching and learning and encompasses (among other things) overall educational purposes, values, and aims" (Koehler & Mishra, 2008, p. 14).
- *Technological Knowledge* (TK)—"knowledge about various technologies, ranging from low-tech technologies such as pencil and paper to digital technologies such as the Internet, digital video, interactive whiteboards, and software programs" (Schmidt et al., 2009–2010, p. 125).
- *Pedagogical Content Knowledge* (PCK)—an understanding of "the ways of representing and formulating the subject that make it comprehensible to others" (Shulman, 1986, p. 9).
- *Technological Content Knowledge* (TCK)—an "understanding of the manner in which technology and content influence and constrain one another" (Koehler & Mishra, 2008, p. 16).
- *Technological Pedagogical Knowledge* (TPK)—"an understanding of how teaching and learning changes when particular technologies are used" (Koehler & Mishra, 2008, p. 16).
- *Technological Pedagogical Content Knowledge* (TPACK)—is the nexus of the three knowledge areas. It "is the basis of effective teaching with technology" (Koehler & Mishra, 2008, p. 17).

"TPACK emphasizes the connections among technologies, curriculum content, and specific pedagogical approaches, demonstrating how teachers' understandings of technology, pedagogy, and context can interact with one another to produce effective discipline-based teaching with educational technologies" (Harris, Mishra, & Koehler, 2009, p. 396). According to Koehler (2011), effective technology integration "requires developing sensitivity to the dynamic, (transactional) relationship between all three components" (p. 5).

Mishra, Koehler, and Kereluik (2009) state that the TPACK framework provides two new approaches to thinking about educational technology. First, the emphasis is on evaluating the complete teaching performance, not just on the technology aspect. Second, it helps educators to make decisions about the technologies which merit learning. "[E]ducators should be able to quickly evaluate new technologies in terms of how they will present content or facilitate pedagogy" (Mishra et al., 2009, p.51). Overall, the emphasis of TPACK is on the "role of teachers as decision makers who design their own educational technology environments as needed, in real time, without fear of those environments becoming outdated or obsolete" (Mishra et al., 2009, p. 52).

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Technology
SEE ALSO EDUCATIONAL TECHNOLOGY

Everybody knows what technology is, but the term is in fact slippery and complex. Educators tend to use the word "technology" as a truncated version of "educational technology", though the broader term "technology" has a vigorous and lengthy history well beyond the confines of pedagogy. Definitions of technology range from the narrow (technology as device) to the broad (technology as system) to the all-encompassing ("If God didn't invent it, then it is technology"). The product definition is seemingly a "common sense" definition, recognizable in the oft-heard line that "technology is only a tool." This approach is best exemplified by the work of Albert Borgmann (1984), who refers to this model as "the device paradigm."

On the other hand, the now classic John Kenneth Galbraith definition from 1967 sees technology as "the systematic application of scientific or other knowledge to practical tasks." Galbraith continues, "Its most important consequence ... is in forcing the division and subdivision of any such task into its component parts. Thus and only thus, can organized knowledge be brought to bear on performance" (Galbraith, 1967, p.12). Technology becomes not only the device, but also the method. From this definition, the shortened (and mistaken) idea of technology as "application of science" has gained some currency.

Most historians of technology today would argue that technology predated science, and that in many cases technology comes first. Raymond Williams (1976, p. 315) reminds us that the historic (seventeenth and eighteenth century) meaning of technology is the "systematic study of the arts," and indeed technology was often synonymous with the phrase "practical arts."

Going back even further, ancient Greek philosophy separated two ways of knowing as *episteme* and *techne*. These can be translated as knowledge vs. craft, or causal knowledge vs. technology, or "knowing that" vs. knowing how." (See Aristotle's *Nicomachean Ethics*, Chapter 6, for a discussion of knowledge as making and doing.)

Jacques Ellul's (1964) analysis of technology broadens the concept by substituting the word "technique" for "technology." Contemporary philosopher of technology Frederick Ferre (1995) attempts a precise definition, saying that technology is the "practical implementations of intelligence" (p. 26). Val Dusek (2006) broadens the domain of technology to include "a complex of hardware, knowledge, inventors, operators, repair people, consumers, marketers, advertisers, government administrators and others" (p. 35).

Brian Arthur (2009) highlights the multifaceted meaning of technology, and looking from the vantage point of the end of the first decade of the twenty-first century, argues that one meaning is not sufficient, and so proposes three different meanings for three different ways to categorize technology. First, "technology is a means to fulfill a human purpose"; second, technology is "an assemblage of practices and components"; and third, technology is "the entire collection of devices and engineering practice available to a culture" (p. 28).

Subcategories of technology are many and include high technology, appropriate technology, information technology, and communication technology. The latter two are often grouped together as information and communications technology, sometimes abbreviated to ICT.

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Technology Education
SEE EDUCATIONAL TECHNOLOGY

Technology-Enabled Learning
SEE ALSO COGNITIVE TOOLS and COMMUNITY OF PRACTICE and COMPUTER-BASED TRAINING and DISTRIBUTED COGNITION and MEDIA UTILIZATION and RICH MEDIA and TECHNOLOGY-ENHANCED LEARNING ENVIRONMENT and VIRTUAL WORLDS

The field of educational technology has evolved as have the technologies used to facilitate learning. Technology in the formal definition of the field refers to both the processes and products practitioners employ to create the appropriate environment for learning to occur. Through emerging product technologies, the environment has changed significantly to include mobile and virtual settings expanding beyond traditional face-to-face situations. The Internet has changed from a static content repository to a place where users can contribute, interact, and collaborate. Bell (2011) suggests that in this connected environment, knowledge is both a commodity and a social activity.

While there is a clear distinction between the processes and products of educational technology, often the emphasis is on the product when referring to technology-enabled learning. The products used for technology-enabled learning have progressed more recently from in-class technologies including computers, projection screens, and student response systems, to technologies for use beyond the traditional classroom to include learning management systems, hand-held mobile devices, and virtual worlds.

An example of technology-enabled learning from both a process and product perspective is technology-enabled problem-based learning (PBL). In this particular environment, the PBL prompts were technology enabled in a Web-based instruction course for teachers (Chen & Chan, 2011). In another example, social learning was emphasized in a virtual world as an interactive learning approach where participants learn but also lead and teach others. Learning in this type of environment is often informal and regulated by the needs of the participants; however, formal learning experiences based on explicit instructional strategies are possible and evident in virtual worlds (Jin, Wen, & Gough, 2010). Capitalizing on the ubiquitous nature of mobile learning, Ryu and Parsons (2011) explored collaborative learning through the lens of flow theory in a reconceptualization they refer to as social flow. Three different types of learning strategies were examined across six different physical locations. Risk taking was used as a condition (challenge) to encourage collaboration; those with higher cognitive curiosity and intrinsic interest took even more risks and collaborated more to overcome challenges (Ryu & Parsons, 2011).

The processes used in technology-enabled learning are largely based on the dominant learning theories that have evolved: behaviorism, cognitivism, and constructivism (Reiser, 2007). Instructional strategies, an example of a process technology, are largely based on these theories (Hooper & Rieber, 1995). As technologies continually emerge and the Internet continues to be embedded in existing culture, alternate theories of learning through technology are suggested to include connectivism, activity theory, communities of practice, actor-network theory, and the social construction of technology (Bell, 2011; Oliver, 2011). As existing theory informs practice in the use of technology for learning, new technologies will serve as a catalyst to encourage alternative strategies for the refinement of existing theory and development of new theory.

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Technology-Enhanced Learning Environment

SEE ALSO MEDIA UTILIZATION and TECHNOLOGY-ENABLED LEARNING

Technology-enhanced learning environments (TELEs) have been defined with an emphasis on the appropriate use of technological resources and the context of the learning environment. The definitions convey the end purpose of educational technology defined by Molenda (2008) as "using appropriate technological resources under conditions conducive to learning" (p. 168). Moreover, definitions of TELEs also emphasize the context of a complex learning environment, generally interconnecting both formal and informal settings with a "physical or virtual space that has been designed to provide optimal conditions for learning, including access to rich resources" (Molenda & Boling, 2008, p. 122).

Some definitions of TELEs begin with identifying or categorizing the appropriate use of tangible technological resources in the learning environment. For example, based on an extensive evaluation of TELEs, Steffens (2008) categorized TELEs into three different classes: (1) container with tutor, (2) content system with tutor, and (3) content systems without tutor (p. 224). TELEs which rated highly were classified as container systems with tutors, such as, learning management or information systems with content provided by the users. These types of TELEs were described as supporting increased opportunities for interaction, feedback and self-regulated learning (Steffens, 2008).

References to TELEs also emphasize the context of the learning environment. Kim and Hannafin (2011) describe TELEs as formal or classroom-based supports for dynamic scaffolding involving teacher, peers, experts, and technology used to augment student problem-solving and inquiry (Kim & Hannafin, 2011). However, many authors describe informal TELEs used for promoting and supporting student collaboration and interactions through computer-mediated synchronous and asynchronous communications, such as peer-to-peer learning, collaborative knowledge building and participatory learning, to name a few (Brown & Hill, 2009; Kok, 2009; Ryberg & Christiansen, 2008).

Kok (2009) provides a comprehensive definition of TELEs from a cognitive perspective incorporating attributes identified in earlier definitions:

> Technology enhanced learning refers to the use of technology to support and enhance learning practice. Technology enhanced learning environments enable access to a range of materials, learning tools and communication facilities, so they can be ideal constructivist learning environments that enable students to become more actively involved in developing their understandings. (p. 3)

Overall, TELEs may be defined as complex learning environments that enable appropriate use of technological resources in order to continually enhance the conditions conducive to learning.

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Theme-Based Instruction

SEE LEARNING BY DOING

Theory-Driven Evaluation

SEE EVALUATION MODELS

Transfer

SEE ALSO CONTEXT

Transfer of learning (or transfer of training, as it is known in the military and corporate realm) refers to the extent to which learners apply newly learned knowledge, skills, and attitudes to real life contexts.

The transfer problem was one of the earliest issues confronted in the scientific examination of the learning process (Thorndike & Woodworth, 1901) and many consider it second to none in importance (Deese, 1958). Educational technology's interest in the transfer problem stems from the field's commitment to increasing the value derived from investments in education (Molenda & Pershing, 2008), that is, improving the payoff of instruction by strengthening the link between instruction and real-world application.

Early research on transfer differentiated between *near* transfer—routine, direct uses of learned skills—and *far* transfer—creative expansion of the learned skill in novel, complex situations. Near transfer of procedural tasks can be enhanced by repetitive practice accompanied by corrective feedback and incentives, but far transfer is more elusive (Clark, 1992). The rich, problem-based learning environments advocated by situated-cognition theorists (or constructivists generally) are an attempt to provide learning conditions that promote more holistic and varied sorts of practice conducive to far transfer (Barab & Dodge, 2008).

Baldwin & Ford's (1988) model of workplace transfer proposes a more systemic view—that successful transfer is a product of the learner's characteristics and a supportive work environment in addition to well-designed instruction. That is, even the most elegant training experience is not a sufficient condition for transfer. The most recent comprehensive review of literature (Blume, Ford, Baldwin, & Huang, 2010) concludes that measurement problems cloud our ability to derive statistically reliable generalizations from field studies of transfer, but that there is strong support for the systemic view that the transfer problem is complex and dynamic, affected by learner characteristics, instructional features, and factors in the workplace environment.

Practical suggestions for improving transfer in the workplace (e.g., Broad & Newstrom, 1992) recognize this complexity and attempt to make sense of it for the practitioner. Milheim's "comprehensive model for the transfer of training" (1994) suggests specific steps that can be taken before, during, and after training to maximize the probability of learners' actually using on the job the desired knowledge, skills, and attitudes.

Formal education settings differ markedly from training settings in that interventions are only applicable *during* instruction because instructors simply have access to learners only in the classroom, not on the job. Therefore, practical suggestions for the promotion of transfer are limited to advice such as providing realistic practice (for simple or near transfer) and promoting metacognitive reflection (for complex or far transfer) (Fogarty & Pete, 2004).

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Transfer Context

SEE CONTEXT

Transformative Evaluation

SEE EVALUATION MODELS

Turn-Based Strategy Game

SEE DIGITAL GAME-BASED LEARNING

Twenty-First Century Literacy

SEE LITERACY

U

Ubiquitous Learning

SEE MOBILE LEARNING

Unified Communication

SEE COMMUNICATION

Universal Design for Learning

SEE ALSO ACCESSIBILITY

Following the perspective of universal design in architecture, universal design for learning (UDL) addresses issues with inaccessible curriculum. The hallmark of UDL is creating flexibility in the curriculum that will benefit all students, “including those whom the innovations were not explicitly intended to help” (Meo, 2008, p. 22). For example, digital text with its capacity for text to speech, enlarged fonts, embedded vocabulary supports are made available to all students. UDL honors the idea that learners are on a continuum and that not all learning needs are evident or diagnosed while recognizing that it does not override the need for special education (McGuire, Scott, & Shaw, 2006).

Planning to meet the needs of individual students is one of the major difficulties with diversity in the classroom (Meyer & Rose, 2006). UDL is a theoretical perspective developed by the founding members of the Center of Applied Special Technology (CAST) to build a “blueprint” that is responsive to the needs of students on the premise that the curriculum should be designed for diversity rather than having to be “retrofitted” to meet specific needs of students (CAST, 2011). UDL uses three principles to created the flexibility needed to dismantle barriers: (1) Multiple means of engagement recognizes that different students are motivated in different ways and that students have different preferences for routine versus variety; (2) Multiple means of expression affords opportunities for students to demonstrate their learning by using a variety of modes such as writing, drawing, video, and drama; and (3) Multiple means of representation utilizes various modes of presenting material such as audio, text, and visual representation to respond to diversity (Meyer & Rose, 2006).

UDL may be confused with assistive technology especially since initially CAST was set up to support students who needed assistive technology in order to gain access to the curriculum (CAST, 2011). During the process of supporting students with special needs, the founding members of CAST recognized that curriculum often creates barriers that impact many students, not just those with diagnosed disabilities. All students, with and without disabilities, may be able to better achieve the learning goals if the inherent barriers are removed.

Although UDL and assistive technology are often used in the same environment and can be supportive for diverse learners, assistive technology is not UDL (Coyne et al., 2006; Edyburn, 2010). UDL seeks to provide environments conducive to the learning needs of all students, not just those who are diagnosed as having disabilities (Meyer & Rose, 2006; Messenger-Willman & Marino, 2010). UDL is not based upon a deficit model of having to prove disability to access supports (Edyburn, 2010). UDL is supported by learning science theory that states “effective learning environments scaffold students’ active construction of knowledge in ways similar to the way that scaffolding supports the construction of a building” (Sawyer, 2006, p. 11). UDL supports changing the goals of education to value “diversification” over “homogenization” with learning environments that promote and foster diverse learning (Meyer & Rose, 2006). They encourage individual growth rather than group ranking (Edyburn, 2006).

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Usability

Usability is defined generally as a measurable quality of designed objects with which humans interact. However, in their database of terms and definitions The International Standards Organization (ISO) describes usability as "the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use" (ISO Concept Database, 2008). In educational technology, usability is associated with design processes and involves optimizing the quality of interactions users have with technological processes and products that enable them to carry out context-specific tasks. The usability of an interface, a technology or device is considered poor whenever the power and performance of the technology falls below the level required by users (Norman, 1998, 2005; Vicente, 2006). Arguably, there is room for improvement in all designed objects; ubiquitous imperfection is the single common feature of all made objects (Petroski, 1992).

User-centered design (UCD) processes anticipate and intentionally respond to users' skills, goals and preferences. Usability is often defined using a set of attributes, criteria, rules and/or goals by which one evaluates the user interface (Nielsen, 1993; Norman, 1988, 1993, 1998, 2005, 2007, 2011; Preece, Rogers, & Sharp, 2007; Schneiderman, Plaisant, Cohen, & Jacobs, 2010). To improve the usability of an interface or device, usability testing and usability studies are woven into all stages of an iterative design process focused on developing interactive technologies and products that are easy to learn, effective to use and enjoyable from the users' perspective.

Preece, Rogers, and Sharp (2007) define usability using six goals:

- Effective to use
- Efficient to use
- Safe to use
- Has good utility/functionality
- Easy to learn
- Easy to remember

From a user interface design perspective, Schneiderman, et al. (2010) build upon several usability rules: strive for consistency, enable shortcuts for frequent users, offer informative feedback & simple error handling, design dialog to yield closure, permit easy reversal of actions, support internal locus of control, and reduce short-term memory load.

Usability can be conceptualized in terms of design principles—generalizable abstractions intended to orient designers' thinking about different aspects of their designs (Preece, Rogers, & Sharp, 2007). Design principles such as visibility, constraints, mapping, consistency and affordance, as well as heuristics (such as user control and freedom, simplicity, error prevention, help and documentation) are promoted to guide the human-centered design of technological systems and interactive products (Nielsen, 1993; Norman, 1988, 1993, 1998, 2005, 2007, 2011; Preece, Rogers, & Sharp, 2007; Vicente, 2006).

Finally, the call for usability testing and good design is not aimed at reducing complexity. Norman (2011), who distinguishes between complexity and confusion, argues that humans don't mind complexity in an object or technological process if it seems appropriate. Moreover, Vicente (2006) maintains that while technological systems are getting ever more complex, the human factors can be addressed through good design and attention to societal needs. Thus, complex technologies can be tailored to specific situations. This is the essence of usability.

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Also See Additional Resources for Further Information on this Subject

User-Centered Design
SEE RAPID PROTOTYPING and USABILITY

User-Generated Content

User-Generated Content (UCG) or Consumer-Generated Content refers to material on Web sites that is produced by the end user of the Web site. Examples of UGC include material posted to wikis (Wikipedia may be the best-known example of UGC), blogs, social networking sites, podcasts, and other Web 2.0 utilities (Hsu, 2007). There are three characteristics of user-generated content. First, UGC entails a modicum of creative effort; the end users must either create the work entirely or add their own value to an existing work. Therefore, copying a portion of a video production and uploading it to an online video Web site would not constitute UGC. If the end user uploads personal photographs, comments in a blog, or posts an original music video, this would be considered UGC. Second, UGC entails a publication requirement, either on a publicly available Web site or a social networking utility accessible to a select group of users via login protocols. (This excludes email and two-way instant messaging from consideration as UGC.) Third, UGC is produced outside of generally recognized professional routines and practices (as opposed to content produced by commercial entities) (OECD, 2007).

The challenge that UGC presents to educational technology is that the student rather than the educator produces the material. Since it lacks editorial control, the quality of UGC is open to question, and in many cases, the material contained in UGC may be inaccurate or inappropriate to the particular academic setting. Other issues associated with UGC concern copyright/fair use policy, privacy concerns and authority records (for purposes of classification, cataloging, and retrieval) (Richards, 2009). However, research has found that UGC leads to greater collaboration among students and improved communication by participants within the subject at hand (Terrell, Richardson, & Hamilton, 2011).

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V

Video Blogs
SEE SOCIAL COMPUTING

Video Conferencing
SEE TECHNOLOGICAL COMMUNICATION

Virtual Learning
SEE DIGITAL GAME-BASED LEARNING and VIRTUAL WORLDS

Virtual Reality
SEE DIGITAL MAPPING and VIRTUAL WORLDS

Virtual Worlds
SEE ALSO AVATAR and DIGITAL GAME-BASED LEARNING and GAME DESIGN

Definitions for virtual worlds vary among scholars and industry professionals (Bell, 2008). Common themes found in literature describe virtual worlds as persistent spaces made available by networked computers which are accessible through a graphical interface, and provide its inhabitants synchronous interactions not only between individuals, but also the environment (Bell, 2008; Schroeder, 2008; Ondrejka, 2008). Virtual worlds are persistent in that objects that are created or brought into the environment will remain for other residents to interact with after one resident has logged-off. Virtual worlds rely on network servers, available over the Internet, which provide collaborative spaces for synchronous social interactions. These interactions are expressed and experienced through the resident's virtual representations called avatars, with movement (e.g., smiling, sitting, building, touching), digital creations, text and/or audio communications including music and sound effects.

An early ancestor of virtual worlds was virtual reality. Virtual reality (VR) was conceived in the early 1960s by filmmaker and inventor Morton Heilig (Reingold, 1991). Heilig invented the "Sensorama" a VR arcade machine that allowed the viewer to experience new environments with 3D movies, stereo sound, wind, motion, and smell. By the 1980s VR had vastly improved due to personal computers, and became a useful 3D engineering design and development tool. However, VR research focused more on interface and less on collaboration (Ondrejka, 2008).

Other important technologies that lead to virtual worlds are MUDs (multiuser domain/dungeons/dimensions), and MOOs (multiuser domain, object-oriented), which were popular text-based virtual environments in the 1970s and 1980s (Nelson & Erlandson, 2007; Ondrejka, 2008; Turkle, 1994). According to Ondrejka (2008), one of the reasons virtual worlds are so hard to define is that they share the same technology and vocabulary as online games. For example, massively multiplayer online role-playing games (MMORPG or MMO) also take place online in within a 2- or 3D graphical interface, with users represented and interacting through their avatars (Steinkuehler & Duncan, 2008). Online games such as MMORPGs are structured with strong fictional back stories, rules, accumulation of points, and/or levels (Ondrejka, 2008). Schroeder (2008) suggests MMOs are a subset of virtual worlds, as virtual worlds may incorporate games, role-play, and simulations. Often virtual worlds are social spaces that contain replicas of real-life and fictional spaces such as homes, neighborhoods, stores, and entertainment facilities (Perkins & Arreguin, 2007).

In 2005 Linden Labs launched a virtual world called Second Life and interest in educational uses of virtual worlds quickly spiked (Barab et al., 2005; Nelson & Erlandson, 2007). Residents of virtual worlds spend a great deal of time educating each other both directly and indirectly (Ondrejka, 2008). This is possible because virtual worlds provide a sense of "being there" present in the environment with other people (Schroeder, 2008). It is the ability for collaborative learning, between people who may be located vast distances from one another, which makes the education potential for virtual worlds something to watch now and in the future.

Aline Click

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Visual and Pictorial Learning

SEE ALSO CONE OF EXPERIENCE and DUAL CODING THEORY and GRAPHICS and MULTIMEDIA LEARNING and SEMIOTICS and VISUAL COMPETENCY and VISUAL MESSAGE DESIGN

The process of learning by means of visual and pictorial representations—pictures, photographs, illustrations, line drawings, charts, graphs, maps, schematics, and the like—has long been assumed to differ from learning via verbal information only. Not only is the process different, but the result is believed to be better. Belief in the special value of visuals underlies the field originally known as visual instruction, later to evolve into educational technology. Early advocates of "visualizing the curriculum" (Hoban, Hoban, & Zisman, 1937) saw this movement as an antidote to the sterile lecture and textbook methods current at the turn of the nineteenth century. As Hoban, Jr., reflected "The battle then as now was against verbalism, except that then the issues were more clearly seen and drawn. Verbalism was words empty of concrete, acted-upon, psychologically transformed meanings of reality as experienced through the senses…" (AECT, 1973, p. 22). Visual media and other more concrete types of experiences, as portrayed in Edgar Dale's "cone of experience" (1946), were proposed as the modern alternative to empty abstraction.

Subsequent research has shifted away from trying to prove that pictures are superior to words in favor of attempting to label and categorize the various types of visuals (e.g., Fleming, 1967) and to understand the role they play in human learning. Many theories—ranging from gestalt to semiotics to neurophysiological—offer explanations of *how* images are received, converted into perceptions, used, and possibly stored in memory (Anglin, Vaez, & Cunningham, 2004).

However, it is the memory function that is of most interest to instructional designers. Visual memory theories tend to revolve around Paivio's (1971) dual-coding theory, which proposes that visual and verbal information are processed along distinct channels in the mind, creating separate representations for each form. Thus, learners would be more likely to remember something if it were stored in memory in both verbal and nonverbal form. Although challenges continue to be raised about this theory, the dual-coding idea has generally been supported in recent studies of brain imaging.

Another line of inquiry, less theory-based, focuses on experimentally comparing different treatments of verbal and visual information to derive generalizations for instructional design. An example is the four-decade long program of research at Pennsylvania State University (Dwyer, 1978; Dwyer, Dwyer, & Canelos, 1989; Munyofu et al., 2007). Dwyer and associates conclude that the effectiveness of visual elements depends on many factors, including the degree of realism, the manner of lesson presentation, learner characteristics, alignment with objectives, attention-focusing methods, and what is tested (Dwyer & Dwyer, 1989). Other programs of visual learning research are described and their findings summarized by Anglin, Vaez, and Cunningham (2004) and Lohr and Gall (2008).

A promising approach for future research on multimedia representations comes from cognitive science. For example, Mayer (2005), groups findings under headings such as the split-attention effect, cognitive load theory, the redundancy principle, cognitive processing management, reduction of extraneous processing, and social considerations that affect motivation. This approach is consistent with the earlier attempt of Fleming and Levie (1993) to develop principles to guide instructional message design, eclectically combining behaviorist, and cognitivist perspectives.

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Visual Communication
SEE COMMUNICATION and GRAPHICS

Visual Competency
SEE ALSO GRAPHICS and LITERACY and PERCEPTUAL MODALITY and VISUAL AND PICTORIAL LEARNING

Visual competency is the process by which individuals operationalize the concept of visual literacy. Visual literacy is an approach to iconic thinking and the grammar of imagery, which continues the tradition of Debes (1968), Arnheim (1969), and Dondis (1973). Visual literacy is commonly illustrated in the constructs of visual learning, visual thinking, and visual communication, as proposed by Randhawa (1978). The relationships between visual thinking, learning, and communication are often explained as laying along a continuum from internal processing, thinking, to external action, communication (Seels, 1994).

Visual messages existed before text-based messaging in the forms of prehistoric pictured communications and other symbol systems, but a single definition of visual literacy that enjoys the consensus of the visual literacy scholarly community is still evolving. However, all definitions of visual literacy refer to the ability to interpret and create visual messages (Smaldino, Lowther, & Russell, 2011). Thus, visual competency applies the concept of visual literacy to make meaning.

Visual competency occurs through the application of seven abilities:

1. Analyze visual image needs.
2. Efficiently locate visual images based on this need.
3. Interpret meanings of visual images.
4. Evaluate visual image sources.
5. Effectively use visual images.
6. Design and create visual images.
7. Understand ethical, legal, social, and economic issues related to using visual images (Visual Literacy Standards Task Force, 2012).

Accurately interpreting the meaning of a visual image depends upon the context, purpose, level of knowledge, interest, and situation (Choi, 2010). However, a semantic gap often occurs when context, purpose, level of knowledge, interest, and situation are misaligned. A visually competent individual is able to close this gap through the application of collection knowledge (how to find), domain knowledge (what to find), and world knowledge (other issues) (Enser, 2000).

Hug (2011) defines visual competency as "those abilities and skills, which are necessary for exploring the tectonics of subjective, inherent and intended meanings and of the qualities of visuals (validity, comprehensibleness, coherence, tenability)" (p. 6). Müller (2008) defines visual competency as "a paradigm for basic research on the production, distribution, perception, interpretation and reception of visuals, aimed at understanding visual communication processes in different contemporary social, cultural and political contexts" (p. 103). Competence is composed of four visual dimensions:

1. Production competence
2. Perception competence
3. Interpretation competence
4. Reception competence

These four dimensions also comprise a visual competence cycle where perception influences meaning attribution, which translates to interpretation. Interpretation may evoke emotional and cognitive reactions which, in turn, influence reception. Reception may evoke physical actions and/or reactions, which impact production. Production leads to dissemination, which is then perceived by individuals. The various definitions of visual competency represent the shifting importance of images and visual media in the changing landscape of what it means to be literate (Visual Literacy Standards Task Force, 2012). Therefore, it is important to evaluate the context in which visual competency is described when determining which definition to use.

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Visual Literacy

SEE LITERACY and VISUAL COMPETENCY

Visual Message Design

SEE ALSO MESSAGE DESIGN and VISUAL AND PICTORIAL LEARNING and VISUAL COMPETENCY

Early research into the interpretation of visuals originated with perceptual psychology (Anglin, Towers, & Levie, 1996). Students need the skills to understand the messages in the visual which can lead to an increase in their motivation and encourage critical thinking (Bazeli & Robinson, 1997). Using information derived from these early days of research, Fleming and Levie created the principles of message design (Molenda, 2008). Although research from the past to the present looked at the impact of visuals, visual message design has always looked at helping learners.

Visual messages are designed effectively by considering many variables (Anglin, Towers, & Levie, 1996). "The use of visuals in education, although consistently shown to aid in learning, must be carefully planned" (Stokes, 2002, p. 16). Among the important features to consider in current visual message design include the use of "words, visuals, and form (Pettersson, 2007, p. 70). Anglin, Towers and Levie (1996) stated that viewers can remember more from a picture that they can from text.

In their work with multimedia learning, Park and Lim (2004) found that using a visual in instructional material may positively affect a learner's interest in the material presented. Visual images not only capture a learner's interest, but may help the learner remember the "context of the illustrated text" (Gagne, Briggs, & Wager, 1988, p. 147). Therefore, messages designed with a visual may increase a learners interest in the material presented.

A visual, when used alongside text, can facilitate learner expectations (Anglin, Vaez, & Cunningham, 2004). Textual elements are accompaniments to the visual and should be considered in visual message design. According to Bix (2002), text is an important consideration in the creation of the message. Levie and Lentz (1982) posited that when written information is reiterated in a visual, learning can occur.

Another aspect to consider in visual message design is the skill of the viewer. Students in today's classroom must be visually literate if they are to benefit from the visuals incorporated in the messages. Visual literacy is defined as "the active reconstruction of past visual experience with incoming visual messages to obtain meaning" (Sinatra, 1986, p. 5). The designer must also consider the emotional impact of the visual for the message to capture the learner's attention. "…if aesthetic form and content are effectively related, the visually literate viewer is able to extract relevant information by concentrating on visible relationships and the nature of meaning making in the brain" (Dake, 2005, p. 16).

Recent research has tuned to the effects of cognitive load on learning when students organize pictures and words in multimedia environments (Mareno & Valdez, 2005). Thus, from the first days of the Gestalt research and the visual, through the 1970s and 1980s when the focus was on message design, the focus has turned to the impact of visual message design and the cognitive load of the learner.

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Vodcast

SEE TECHNOLOGICAL COMMUNICATION

W

Web 2.0

SEE ALSO CLOUD COMPUTING and SOCIAL COMPUTING and SOCIAL MEDIA

Web 2.0 defined conceptually is interactive and participatory information sharing, creation, and collaboration by users on the World Wide Web. When characterized using a set of Web applications, Web 2.0 includes social networking sites (e.g., Facebook, Google+, Twitter), blogs, wikis, video and photo sharing sites (e.g., YouTube, Metacafe, Photobucket, Flickr), hosted services, Web applications (e.g., word processors, spreadsheets, presentation tools, video editing), mashups and folksonomies (i.e., collaboratively creating and managing tags to annotate and categorize content). Best known is Tim O'Reilly's (2005) definition of Web 2.0 as embracing the power of the Web to harness collective intelligence, which he formulated, in part, by comparing and contrasting Web 2.0 with Web 1.0 functionalities and applications (see Table 2).

O'Reilly (2005) described seven principles that were used to classify an application or approach as Web 1.0 versus Web 2.0, and provides features and core competencies that demonstrate the difference between the two concepts (see Table 3).

Web 2.0 supports a different quality of user interaction and experience, one that Harrison and Barthel (2009) argue is based on a radical reconceptualization of the user from consumer to producer. Web 2.0 is an environment that enables users with little technical knowledge to construct and share media and information products, that supports more dynamic interactions between clients and servers, and provides more engaging visual displays and applications; ultimately, Web 2.0 provides more direct, interactive and participative user-to-user interactions by pooling the collective and collaborative efforts of potentially millions of users (e.g., Digg.com, which ranks news stories based on user votes) (Harrison & Barthel, 2009). The authors argue that users are gratified in significant ways by their ability to play an active role in generating content, remixing, redistributing and reconsuming media products, rather than passively consuming what has been created for them by others. With reference to blogging and the wisdom of crowds, O'Reilly offers this insight: "The world of Web 2.0 is also the world of what Dan Gillmor calls 'we, the media', a world in which 'the former audience', not a few people in a back room, decides what's important" (2005, p. 46). The term prosumer, a combination of producer and

Table 3 Web 2.0 principles and features/core competencies (O'Reilly, 2005)

Web 2.0 principle	Features/core competencies
The Web as platform	Netscape application versus Google platform
Harnessing collective intelligence	Users add value; Yahoo catalogue versus Google's PageRank, Amazon's user engagement; blogging and the wisdom of crowds
Data is the next "intel inside"	Applications increasingly data driven; who creates, owns and controls the data
End of the software release cycle	Daily operations become a core competency; users treated as co-developers; leveraging long tail through customer self-service
Lightweight programming models	The perpetual beta; loosely coupled, cooperative systems; syndication not coordination; designed for hackability and remixability; innovation in assembly
Software above the level of single device	iTunes/iPod combination of Web services and mobile devices; TiVo
Rich user experiences	Active and remixable content; rich user interfaces; accessible anywhere; social presence, participation and networking

consumer was originally coined by Alvin Toffler in 1980 and related to Marshall McLuhan and Nevitt's (1972) idea that electric technology will enable consumers to become producers. The term is remixed as "presumption" by Ritzer and Jurgenson (2010), as in prosumers who create value for Web 2.0 companies without receiving wages. Tapscott and Williams (2006) describe the new Web as principally about participation rather than passively receiving information.

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Also See Additional Resources for Further Information on this Subject

Web-Based Training
SEE VIRTUAL LEARNING

Web Conferencing
SEE TECHNOLOGICAL COMMUNICATION

Webinar
SEE TECHNOLOGY-ENABLED LEARNING

Weblog
SEE BLOG

Well-Structured Problem
SEE PROBLEM

Whole-Task Practice
SEE PRACTICE

Whole-Task Sequencing
SEE SEQUENC ING

Wiki
SEE SOCIAL COMPUTING

Working Memory
SEE COGNITIVE LOAD and DUAL CODING THEORY and MEMORY

Z

Zone of Proximal Development

SEE AUTHENTIC ACTIVITY and COGNITIVE DISSONANCE THEORY and SCAFFOLDING

ERRATUM

Avatar

R.C. Richey (ed.), *Encyclopedia of Terminology for Educational Communications and Technology*, DOI 10.1007/978-1-4614-6573-7 pp 20,

DOI 10.1007/978-1-4614-6573-7_2

The author for the entry term Avatar was listed incorrectly on page 20 as Jason Underwood. The correct author's name is Aline Click.

The online version of the original chapter can be found at http://dx.doi.org/10.1007/978-1-4614-6573-7_1

Additional Resources

Audiovisual Instruction

(Additional information about the history of audiovisual instruction can be found in the following resources:)

Reiser, R.A. (2012). What field did you say you were in?: Defining and naming our field. In R.A. Reiser & J.V. Dempsey (Eds.), *Trends and issues in instructional design and technology* (3rd ed., pp. 1–7). Boston, MA: Pearson Education.

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Digital Divide

The Digital Divide Institute: http://www.digitaldivide.org/.

DigitalDivide.org, the site of Digital Divide Institute (DDI), formulates innovations to enhance social, environmental, cultural and human impacts of the internet as it spreads towards remote regions of the planet. Its focus is called “Meaningful Broadband”.

e-Portfolio

If you wish to view a collection of e-Portfolio links, please see http://delicious.com/crichtos/eportfolio.

Evaluation

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Expert Systems

The Association for the Advancement of Artificial Intelligence (AAAI) is an excellent source for additional information and resources (see http://aaai.org/AITopics/ExpertSystems).

Information Classification

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Perceptual Modality

This website gives a yearly summary of publications on perceptual modality research:

Crossmodal Research Laboratory, Experimental Psychology, University of Oxford. http://psyweb.psy.ox.ac.uk/xmodal/index.htm.

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Gredler, M. E. (2007). Of cabbages and kings: Concepts and inferences curiously attributed to Lev Vygotsky (Commentary on McVee, Dunsmore, and Gavelek, 2005). *Review of Educational Research*, *77*, 233–238.
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