Handbook on Instructional Media & Learning Environments

Featuring Topics on:

Instructional Technology, Instructional Media Selection,

Technology in the Classroom,

Distance Learning, Learning Environments,

Instructional/Cognitive Learning Strategies,

Instructional Authoring Systems & Learning Platforms

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Introduction to Instructional Technology

Over the past 50 years, the field and profession of instructional technology has evolved significantly, especially given the dramatic changes in the profession due to technological innovation. In the rapidly evolving profession of instructional technology, change is inevitable, and tomorrow will bring newer and better technologies that support learning and accompanied by a new set of challenges, but the goal of instructional technology is the same: Optimize the technology without sacrificing instructional quality.

The Association for Educational Communications and Technology (www.AECT.org) has been a major source in the defining the field of instructional technology and providing guidance to instructional technology professionals.

Defining Instructional Technology

Due to the intensive training during the Second World War, when large numbers of personnel had to be trained, it was imperative that innovative methods of training had to be adopted. Consequently, the use [then] of new technologies such as the movie camera, overhead projector, and radio, were adopted for use as instructional aids. What followed was the study of these instructional aids and their impact on the process of instruction, which subsequently became known collectively as instructional technology (Jones, 1999, as cited in Lynne, Barker, & Bennett, 2009). Not surprisingly, then, early definitions focused on instructional media—the physical means via which instruction is presented to learners.

In the early 50's to mid 60's, instructional technology appears to have been originally designed as a partner to the classroom teacher to assist in the delivery of educational material. In 1963, efforts to define this field was introduced, which later was accompanied by many iterations. However, a formal definition was adopted circa 1977: as a systematic way of designing, carrying out, and evaluating the total process of learning and teaching in terms of specific objectives, based on research (Jones, 1999, as cited in Lynne, Barker, & Bennett, 2009).

In the early years, many have associated instructional technology with instructional media, where early definitions of instructional technology were based upon instructional media, per se, the physical means by which instruction was presented to students. The term instructional media was widely accepted ad being the physical means by which instruction was presented to learners (Reiser & Gagne, 1983, as cited in Reiser & Dempsey, 2012).

In 1963, the first definition to be approved by the major professional organization within the field of educational technology was published, and it indicated that the field was not simply about media. This definition (Ely, 1963, as cited in Reiser & Dempsey, 2012), was a departure from the traditional view in that the definition focused on *the design and use of messages which control the learning process* which placed an emphasis on learning rather than instruction.

The earlier definition of instructional technology, proposed by Seels & Richey and endorsed by the AECT, was the *theory and practice of design, development, utilization, management, and evaluation of processes and resources for learning.* This definition was later refined to *the problem analysis, solution design, development, implementation, management, and evaluation of instructional processes and resources to improve learning and performance in education and at work* (Seels & Richey, p. 4, as cited in Reiser & Dempsey, 2012).

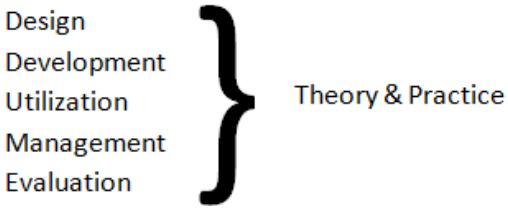
However, with the emergence of computer-mediated and internet/ web-based technologies, the term instructional technology has taken on a much broader meaning. In their book on *Trends and Issues in Instructional Design and Technology (3rd ed.)*, Reiser & Dempsey (2012) defined instructional technology as:

> *"the analysis of learning and performance problems, and the design, development, implementation, evaluation and management of instructional and non-instructional process and resources intended to improve learning and performance in a variety of settings*[with their diverse set of learners]*, particularly educational institutions and the workplace."*

Domains of Instructional Technology

The domains of instructional technology was built around Seels & Richey definition (cited in Reiser & Dempsey, 2012), yet still valid today. It is important to note that when defining a field, means for identifying and organizing relationships emerge from theory and practice, as depicted in Figure 1. Theory consists of concepts, constructs, principles, and propositions that serve as the body of knowledge, whereas practice is the application of that knowledge to solve problems.

Figure 1: Domains of Instructional Technology (AECT, 2001)



The five domains of instructional technology are (Seels & Richey, as cited in Reiser & Dempsey, 2012):

- Design
- Development
- Utilization
- Management
- Evaluation

Development: Refers to the process of translating the design specifications into physical form. Sub-domains include:

- Print Technologies
- Audiovisual Technologies
- Computer-Based Technologies
- Integrated Technologies

Design: Refers to the process of specifying conditions for learning. Sub-domains include:

- Instructional Systems Design
- Message Design
- Instructional Strategies
- Learner Characteristics

Utilization: Refers to the use of processes and resources for learning. Sub-domains include:

- Media Utilization

- Diffusion of Innovations
- Implementation and Institutionalization
- Policies and Regulations

Management: Refers to processes for controlling instructional technology. Sub-domains include:

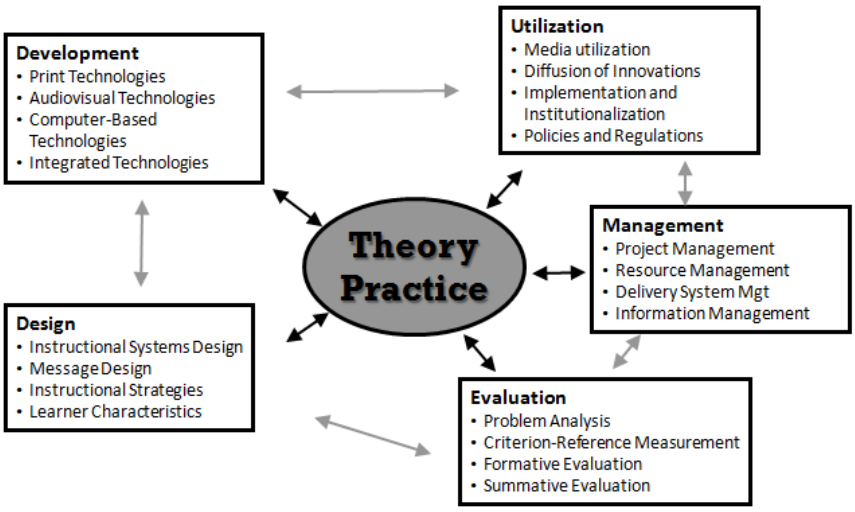
- Project Management
- Resource Management
- Delivery System Management
- Information Management

Evaluation: The process for determining the adequacy of instruction. Sub-domains include:

- Problem Analysis
- Criterion-Referenced Measurement
- Formative Evaluation
- Summative Evaluation

While the relationship among the domains appears linear, they are synergistic in that practitioners can draw from one domain and apply it to another domain when designing the most appropriate learning intervention strategy (Figure 2). Nonetheless, the domains are very similar to the steps that comprise the "systematic" processes described in the previous definitions (Reiser & Dempsey, 2012).

Figure 2: Domains of Instructional Technology (AECT, 2001)



Role of Instructional Technology

Instructional technology has often been used synonymously with educational technology, and indeed, has been often used interchangeably. The term "education" refers broadly to activities and resources that support learning, and "technology" refers to the application of scientific knowledge for practical purposes. Consequently, in the broadest application, educational technology primary goal is to improve "education" and facilitate knowledge through the use of technology.

While there are minor distinctions between educational technology and instructional technology, this lesson will focus on the role of instructional technology, which may include some of the same components associated with educational technology.

Role of Instructional Technology

The ultimate goal of instructional technology is the improvement of human perforce through the systematic applications of the core concepts of instructional technology. It is important to remember that simply integrating technology in a learning environment does affect learning outcomes but instead it is the application and design of instructional technology that has an effect on learning outcomes. To that end, instructional technology is a tool used to solve instructional problems and enrich the learning process.

Using Instructional Technology to Identify Learning Gaps

Instructional technology is more than simply using technology to delivery instructional content…it involves not only analyzing the learning environment and identification of the knowledge gaps, but also designing instructional and cognitive learning strategies and learning activities to facilitate learning.

While instructional media are the physical means by which a lesson or instruction is communicated and delivered, instructional technology is process focused. Specifically, the integration of various instructional media in course design is essential to effective teaching and learning, research has shown that learners retain more information.

The Science of Instructional Media

To that end, when considering the role of instructional technology, specifically that of integrating instructional media into the classroom, it is imperative to examine research from cognitive science. More specifically, humans are *multi-sensory* in that the brain performs several activities at once when processing information (e.g., tasting and smelling, hearing and seeing), but are processed through different channels in the brain.

Studies have shown that *how information is presented* determines the retention level of the information. Cognitive science has revealed learners differ in their abilities with different modalities, but teaching to a learner's best modality doesn't affect learning outcomes. What does matter is whether *the learner is taught in the content's best modality*…students learn more when content drives the choice of modality.

Relationship of Instructional Technology to Instructional Design

Similar to the evolution of instructional technology as a discipline, modern principles of instructional design (ID) traces its roots back to World War II. As the learning and development field advanced in the 1960s and 1970s, instructional systems design (ISD) models began to emerge.

Reiser & Dempsey (2012) define instructional design (ID) as a system of procedures for developing education and training curricula in a consistent and reliable fashion, whereas as in *The Systematic Design of Instruction* defines instructional systems design (ISD) as the systematic approach to developing instructional materials by integrating the processes (phases) of analysis, design, development, implementation, and evaluation (Dick, Carey, L., & Carey, J., 2009).

To that end, instructional technology is similar to ISD in that it is systematic process with inter-related parts (domains) that, when combined, work together in a synergetic way to support the learning process. Isolating a single component of that process is like trying to determine how an automobile runs by studying only the carburetor. However, looking at instructional technology from a holistic view as to

how the components are related, one can then better understand the discrete parts in relation to the whole.

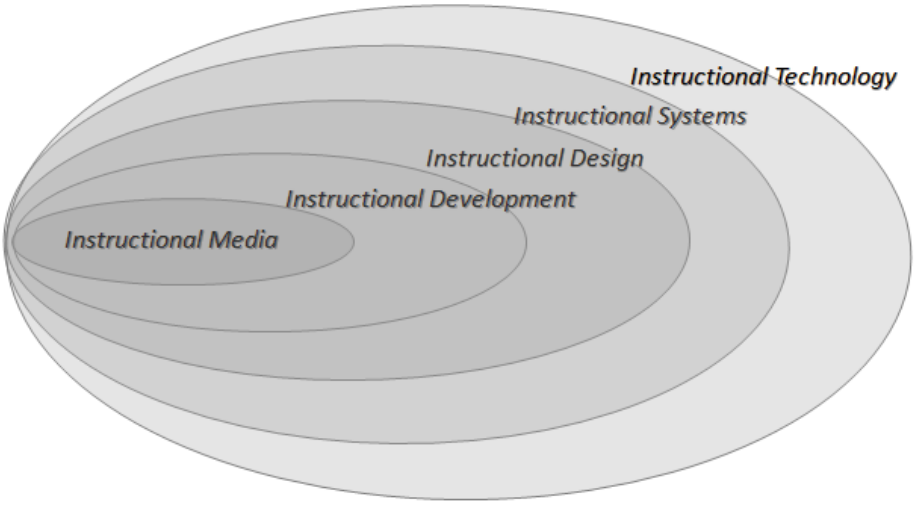
Instructional Technology Components

The following describes the components of instructional technology as depicted in the figure:

- *Instructional Technology* is the highest order in that it focuses on theory and practice.
- *Instructional Systems* is more specific in that it focuses on the arrangement of resources and procedures used to promote learning.
- *Instructional Design*s the systematic process of planning instructional systems.~~,~~ *Instructional Development* is the process of implementing the design plans.
- *Instructional Media* is the culmination of the process in that they are the materials that teachers used to teach and students use to learn.

In the simplest expression, Instructional Technology = Instructional Design + Instructional Development, as depicted in Figure 3.

Figure 3: Instructional Technology Components



As noted in their text *The Systematic Design of Instruction* (Dick, et al., 2009), there is no single best model for designing instruction, in that all ID models share the basic components, in some form or another analysis, design, develop, implement, and evaluate.

Collectively, these ID models and concomitant processes represent what is commonly referred to as *instructional systems design*, and *instructional technology*, with its five domains, encompass all of the principles of ISD.

Instructional Technology in the Classroom

Technology Insertion in the Classroom

Technology insertion/integration in the classroom has been an ongoing and iterative process, albeit accelerated in the past decade. Ten years ago, these 21st Century educational technologies, such as tablets, smartphones, social media, and immersive learning environments, did not exist. Now, with the

emergence of Web2.0 technologies adapted to the classroom, teachers/instructors are more empowered than before in providing innovative methods in facilitating and achieving student learning outcomes.

"Not all students learn the same way and we can really individualize instruction using technology. When our students get into college and beyond, they are much more experienced with a variety of different technologies and how to use them. We really do think we are building 21st-century learners " (Classroom Technology: Effective Instructional Tools for an Evolving Learning Landscape, 2015).

Simply stated, *technology insertion in the classroom is the integration of any technology used to display and/or deliver information that supports student learning experiences and/or facilitate learning achievement.*

Components (instructional media) of a Technology Integrated Classroom

- *Interactive Instruction* - Using video conferencing and/or web conferencing to create a media rich, interactive learning environment. Provides for two-way interaction (visual and aural) and peer-to-peer interaction
- *Personal Response Systems* - Handheld devices to collect and graphically display student answers to teacher/instructor questions. Supports a dialectic learning environment and immediate formative feedback.
- *Mobile devices* - Smartphones/tablets can be used to record student assessment data directly into a handheld device that transfers data to a computer; ability to access information (World Wide Web) via the Internet. Supports discovery learning and exploratory learning.
- *Computer-based Instruction* - Self-paced, stand-alone learning modules that allow time for reflection, repetition, review, and student-computer interaction. Supports immediate formative feedback and reinforcement of instructional objectives and content.
- *Virtual Worlds (Multi-User Virtual Environments (MUVEs)* – An immersive, 3D (dimensional) learning environment that can support visual and oral interaction through the use of avatars. Can support group collaboration and higher cognitive learning objectives.

Benefits of a Technology Integrated Classroom

- Creates an engaging and motivating learning environment
- Creates the foundation for personalized learning
- Enhances a student-centered learning environment
- Promotes collaborative and peer-based Learning
- Provides for blended learning opportunities
- Creates opportunities for specialized and/or individualized Instruction

Differentiating Between Insertion of Technology and Instructional Media in the Classroom

The terms technology insertion and instructional media in the classroom are synonymous in that the purpose and results support the same instructional goals…improving student learning and increase learning opportunities.

The term technology insertion evolved later than the term instructional media, which originally was coined in the 1950's as the physical means via which instruction is presented to learners. However, with

the introduction of computers in the classroom in the early1970's, followed decades later by the integration of the Internet and Web2.0 technologies, *technology integration* became the more popular term associated with 21st Century learning.

Given the current rapidly changing rate of current technologies and the emergence of new technologies, teachers/instructors are continually challenged to maintain technological competency in order to teach in ways to ensure students master the content. Subsequently, students must be empowered to be self-directed learners so they are equipped with the necessary skills to navigate the constantly changing technology environment typical of the 21st Century workplace.

Consequently, it is incumbent upon the teacher to integrate technology in the classroom to help students develop the skills they need throughout their career and professional practice.

Introduction to Instructional Media

Increasingly, educators and trainers are challenged within their respective organizations to provide for the efficient distribution of instructional content using instructional media. The appropriate selection of instructional media to support learning is not intuitive. On the contrary, it is a systematic sequence of qualitative processes based on sound instructional design principles.

Consequently, this lesson will define instructional media, introduce you to the family tree of instructional media, and define and identify synchronous and asynchronous instructional media.

Defining Instructional Media

In the past, many associated instructional technology with instructional media since there was little distinction between the two terms. During that time, most educators viewed instructional media as supplementary means of presenting instruction. In contrast, teachers and textbooks are generally viewed as the primary means of presenting instruction.

In a prior lesson, instructional media was defined as being the physical means by which instruction was presented to learners. However, even with the emergence of computer-mediated and web/online-based technologies, the term has changed little.

Given the growth of distance/online learning, instructional media has evolved to the point where it includes any device by which instructional content is presented and/or delivered to learners. These "devices" include technology and non-technology based instructional media, such as:

- Print
- Chalkboard/blackboard
- Interactive white boards (electronic white board)
- Computer-mediated devices
- Overhead projects/screen displays
- Satellite
- Video/audio conferencing
- Web-based
- Instructional TV (cable)
- Mobile devices (smartphones, smartpads, MP3 players)

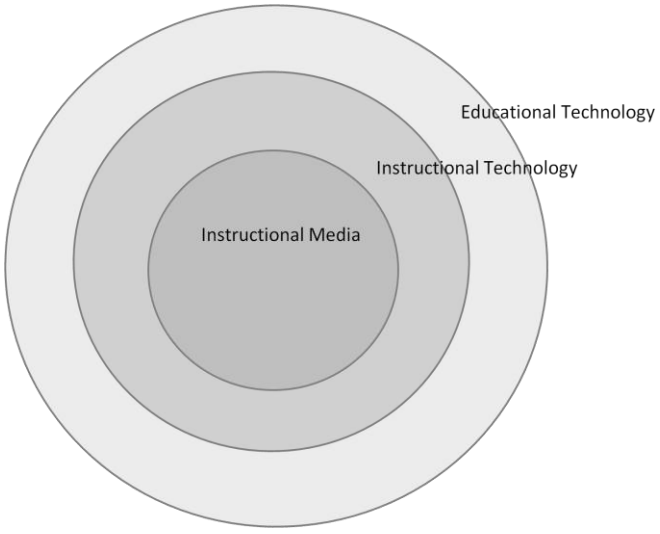
Regardless of the device used to delivery/display instructional content, the selection of the most appropriate instructional media must ensure that a specific instructional medium can support the attainment the learning objective(s). Instructional media are tools used to display and deliver instructional content. As in any tool, the efficacy is only as good as the individual wielding the tool. Instructional media is not just a means to an end; instructional media is an *enabler* that it assists in the delivery of instruction. This is evidence by a major study conducted by the U.S. Department of Education entitled *Evaluation of Evidence-Based Practices in Online Learning A Meta-Analysis and Review of Online Learning Studies* (2010) where they found "the majority of studies found no significant difference across media types is consistent with the theoretical position that the medium is simply a carrier of content and is unlikely to affect learning per se (Clark 1983, 1994, p. 40)". Richard Clark's epic statement over thirty years ago is still applicable today:

> *"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 nutrition… only the content of the vehicle can influence achievement" (Clark, 1983)*

Hierarchical Relationship Between Instructional Technology, Educational Technology, and Instructional Media

Generally speaking*, educational technology is the application of research, learning theory, and technologies to solving instructional problems*, while *instructional technology focuses more on the instructional process.* To that end, many consider instructional technology to be a subset of educational technology, where instructional media is the final step in both processes in that it delivers/displays the content to the learner. The hierarchical relationship between these three processes is depicted below.

Figure 4: Relationship between Instructional Technology & Educational Technology



The AECT states instructional technology is a subset of educational technology to where instructional technology presents refinements not found in meanings of educational technology. They conclude the difference is where instructional technology refers to the concept, theory, and field that focus on facilitating learning through technology under conditions that are purposive and controlled. The AECT's rationale is education and instruction refer to broader or narrower processes, where instruction is

narrower than education in the sense that it refers to situations that are more purposive in which the learner is directed toward specific goals or objectives.

Synchronous and Asynchronous Instructional Media

An analysis of available technologies must include a thorough examination of the advantages and limitations that each presents within the learning environment. Consideration must be given to instructional objectives, development and deployment of instructional strategies, level and type of interaction between the instructor and the student, display of visual images, responsiveness to changes in course content, efficiency of the delivery system, and total system cost.

The *Taxonomy of Distance Learning Instructional Media Table* is designed to assist in determining the most appropriate instructional medium for a specific learning application. The taxonomy is focused primarily on a dichotomous learning environment—*synchronous* or *asynchronous*, and will aid the instructional designer or teacher in determining the most appropriate medium to be selected.

Note: The instructional designer/teacher may choose a combination of media to meet the desired learning objective(s).

Synchronous media. Those devices that contain a live (real time) component and capability of two-way interaction.

Asynchronous media. Those devices that do not contain a live (pre-recorded/delayed) component and are only capable of one-way delivery.

Figure 5: Taxonomy of Distance Learning Media (Holden & Westfall, 2010)

	Synchronous	Asynchronous
VISUAL ONLY (include graphics)	➡ Interactive white boards	➡ Correspondence ➡ Pre-recorded video
AURAL ONLY	➡ Audio Conferencing	➡ Pre-recorded Audio (MP3 players/Podcasts
VISUAL & AURAL	➡ Instructional Television/Satellite e-Learning ➡ Video Teleconferencing ➡ Web Conferencing ➡ Interactive White Boards (IWB) ➡ Virtual Worlds ➡ Smartphones/smartpad	➡ Pre-recorded video ➡ Computer Based Instruction ➡ Asynchronous Web Based Instruction (WBI) ➡ Instructional Television (cable) ➡ Vodcasts

Role of Instructional Media

Given the rapid growth of new technologies that can be adapted to the classroom, instructional media has become an important facet of the instructional technology process. Consequently, this section will introduce you to the basics of instructional media that include a brief description of the evolution of instructional media, and role of instructional media in the classroom including its use and criteria for creating an instructional media plan.

Evolution of Instructional Media

In the broadest sense, instructional media is the physical means to the deliver and/or present instructional content. From the early years of the classroom-based chalk blackboards to self-paced computer mediated learning, and content delivered anytime, anyplace to the individual, the one constant in this evolutionary journey is technology will continue to evolve. Change is inevitable, and tomorrow will bring newer and better technologies that support learning.

Therefore, to prepare for the technological innovations of the future, tracing the evolution of instructional media from the past to the present may illuminate the path to future innovations.

At the dawn of technology- enabled era, there were limited *Instructional media* options (print and chalkboard). However, as e-learning emerged, technological choices available to the instructional designer increased significantly. Depicted and described below (Figure 6) is the evolution of instructional media spanning 120 years.

In the beginning, there were *only* correspondence courses. As the country grew and evolved from an agrarian society to an industrialized nation, the demand for education increased significantly. With the ensuing emergence of radio and TV, the education community quickly realized the potential of these new media and adopted them to distribute education programs to a geographically dispersed workforce.

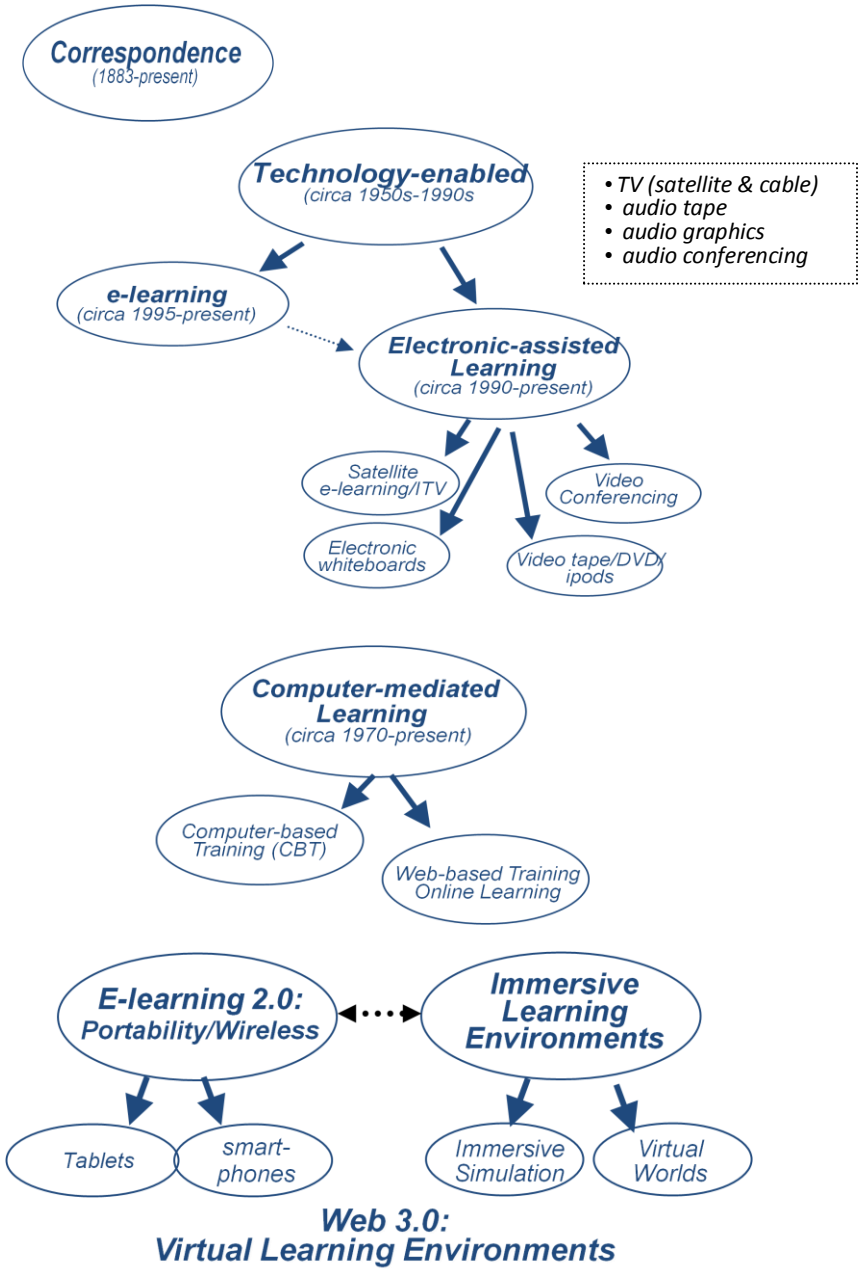
Then, as the technology evolved, more delivery tools emerged to where the instructional designer now has a plethora of choices that can be used singularly or integrated to create learning solution.

In the early 90's, a migration began from a mainframe-centric environment to a more of a stand-alone "distributed" computer environment that allowed for more local hosting of computer-based training (CBT). With the introduction of the computer, learning communities quickly realized the potential of this powerful new technology and adopted it as another delivery tool. As the computer continued to evolve, a new generation of the computer-mediated instruction arrived, and with the emergence of the internet, new collaborative tools and delivery media also appeared.

The evolution of instructional technology will continue as newer technologies are discovered, and they will be accompanied by new terms and lexicons. For example, 25 years ago, there was no such thing as online learning or e-learning, and 10 years ago no one ever heard of immersive learning environments or web 2.0. As instructional technology continues to evolve, so must the instructional technologist. Change is inevitable, and tomorrow will bring newer and better technologies, accompanied by a new set of challenges, but the goal is the same: Optimize the technology without sacrificing instructional quality.

For more detailed information on the evolution of instructional media and distance education in the U.S., click here for the article entitled *Distance Education in the United States: Past, Present, and Future.*

Figure 6: Evolution of Instructional Media



Instructional Media in Schools

The use of instructional media in schools is quickly becoming, if not already, a strategic tool to facilitate learning. Instructional media in the classroom not only facilitates learning, but can reach well beyond the walls of the traditional classroom. Instructional media directly involves the teacher's use and knowledge of the medium, as well as the expected level of student engagement.

The use of instructional media in the schools could include these applications and can support either a synchronous or asynchronous application:

- Primarily used to *display visual* content originating in the classroom. Some examples are:

- Blackboards
- Electronic whiteboards (click here for an example)
- Overhead projector
- Visual display devices (TVs, computer monitors)
- Video players
- Computers (CDROM/DVD)
- Print

- Primarily used to *display visual* content originating outside the classroom. Some examples are:
  - Instructional TV (wireless, cable, or other dedicated circuit)
  - Video Conferencing (web-based or dedicated circuit…click here for an example)
  - Satellite (wireless…click here for an example)
  - Interactive white boards [If connected via the Internet or dedicated circuit]
  - Virtual worlds (multi-user virtual environment-MUVE…click here for an example)
  - Web-based training (click here for an example)
  - Web Conferencing [If connected via the Internet or dedicated circuit…click here for an example]
  - Smartphones/smartpads
  - Vodcasts (click here for an example)
- Primarily used to hear (aural) content originating within or outside the classroom. Some examples are:
  - Audio conferencing
  - Interactive white boards [If connected via the Internet or dedicated circuit]
  - Audio tapes (MP3 players)
  - Podcast/RSS feeds (click here for an example)
  - Reading machines (allows visually impaired students to read printed material)

For more Podcast and Vodcast examples, click here.

Developing an Effective Media Plan

The dissemination of content through the use of instructional media is only as effective as the quality of the instruction. Regardless of the learning environment, instruction is designed to transfer knowledge from the instructor to the learner to the real-world environment. To that end, the transfer of knowledge is facilitated by the development an instructional media plan.

When creating a media plan, some variables to consider are:

- Learning objectives
- Instructional strategies
- Learning activities
- Cognitive engagement
- Synchronicity, i.e., either synchronous or asynchronous or a combination thereof, e.g., blended learning

Instructional strategies have proven to be effective in facilitating the transfer of learning, and because in any given program of instruction there are multiple learning objectives, it follows that finding the right medium-to-objective match will likely result in an effective instructional media plan.

Note: While instructional strategies focus on the transmission of knowledge and describes the general components of a set of procedures used to enable student mastery of learning outcomes, cognitive learning strategies are methods used to help learners link new information to prior knowledge (Driscoll, 2005).

Criteria for Effective Classroom Delivery

An analysis of available technologies must include a thorough examination of the advantages and limitations that each presents within the learning environment. Consideration must be given to instructional objectives, development and deployment of instructional strategies, level and type of interaction between the instructor and the student, display of visual images, responsiveness to changes in course content, efficiency of the delivery system, and total system cost.

Recent research has highlighted the value of the use of visuals in the classroom to facilitate learning. Consequently, visual literacy has become an accepted, and in some cases, an imperative knowledge set with respect to curriculum and/or course development.

So what is visual literacy? The phrase "a picture is worth a thousand words" is often used to emphasize the importance of visuals, and emerging neuroscience and visualization research reveals glimpses of the science behind the saying…visuals *do* matter (Multimodal Learning Through Media: What the Research Says, 2008).

There is a difference between the way the brain remembers words and remembers visuals. The brain has an extraordinary capacity to remember visual information. This is because visual processes evolved over millions of years, so the brain machinery is highly efficient in storing and recalling visual information (The Neuroscience of Learning: A New Paradigm for Corporate Education, 2010).

Since neuroscience has revealed 90% of what the brain processes is visual information, one's *primary learning modality is visual.* In his book on *Brain-Based Learning* Jensen (2008),, states that 80 –90% of information absorbed by the brain is visual in nature. What's more, the brain processes visual information 60,000 times faster than textual information. However, most learners are multi-modal and multi-sensory and adapt their strategies accordingly. In fact, studies have revealed that presenting material in two media—pictorial and verbal—is generally superior to presenting material in only a single medium—as long as the pictorial information is well designed and congruent (Clark & Mayer, 2011).

Since sound technologies have lagged behind visual technologies, instructional designers and teachers have often overlooked using sound to facilitate learners' understanding of content being presented using computer mediated learning. This unintentional oversight appears to be a matter of just not knowing how to use audio when to enhance learning. Consequently, in the absence of visuals, the focus on audio quality should be a consideration when developing audio-only content based.

Instructional Media Selection Process

As instructional media continues to evolve, propelled by advances in technology and fueled by the need to increase learning opportunities, the evolution and advancements of instructional media will continue to accelerate as well. As a result, instructional media selection will become an integral component in developing a comprehensive learning strategy. Although media is often mentioned when studying the

discipline of instructional technology or Instructional Systems Design (ISD), it is sometimes overlooked when applying the selection process to a specific learning environment.

Therefore, this lesson will highlight the essentials of good media selection based upon an instructionally sound and systematic approach to selecting the most appropriate media for the delivery of instructional content.

The Media Selection Process

The instructional media selection process is a systematic approach and an integral component of the instructional systems design (ISD) process. When selecting the most appropriate instructional media, consideration must be given to a number of variables that may influence the selection of one medium over another. Using a systematic approach to media selection ensures that appropriate instructional media are employed to support desired learning objectives.

Media selection analysis must evaluate general and specific criteria, including instructional, student, and cost aspects for each delivery technology (or instructional medium) to ensure attainment of the instructional goal.

Consideration must also be given to selecting the most appropriate instructional strategies that support any specific medium or combination of media. Quite simply, certain synchronous instructional technologies such as satellite e-learning, video teleconferencing, and synchronous web-based instruction, are best suited for instructional strategies that require a live and dialectic learning environment. Conversely, there are asynchronous instructional technologies that are best integrated with strategies that require asynchronous learning environment.

Media selection is s process of identifying the most appropriate medium or set of media for a specific instructional endeavor. That said, listed below are some general considerations for media selection

- A Significant factor in learning: *Quality instruction*—not technology
- An important factor in media selection: *Instructional objective*
- The level of [cognitive] objectives is a critical variable to consider

Synchronous and Asynchonous Learning Environments

A synchronous learning environment supports live, two-way oral or visual communications between the instructor and the student. This exchange of information facilitates the transfer of knowledge from instructor to the student and can be achieved by 1) the use of audio response systems that support oral communications only; 2) the use of interactive remote keypad devices [integrated with Interactive White Boards] that support both the exchange of data and voice; or 3) the use of video-conferencing/web-based technologies. Synchronous learning also incorporates these elements (Holden & Westfall, 2010):

- Provides a dialectic learning environment with varying levels of interactivity
- Encourages spontaneity of responses
- Allows for optimal pacing for best learning retention
- Allows for immediate reinforcement of ideas
- Controls length of instruction when completion time is a constraint
- Is constrained by time, but not place

An asynchronous learning environment exists when communication between the instructor and the student is not real-time. Examples of asynchronous instruction in a distance learning environment are the use of text materials (print or electronic), and online discussion boards where students respond to questions from the instructor or other students. Asynchronous learning also incorporates these elements:

- Provides for more opportunity for reflective thought
- Not constrained by either time or place
- Delays reinforcement of ideas
- Provides for flexibility in delivery of content
- May have higher attrition rate and may extend time for completion

Instructional Media Options for Distance Learning

When selecting the most appropriate instructional media for distance learning, consideration must be given to a number of variables that may influence the selection.

Instructional issues to consider:

- Identification of knowledge and skill gaps
- Effective assessment and measurement tools
- Level of interaction (didactic versus dialectic)
- Instructional strategies
- Complexity of content & rate of content change
- Rate of content change

Delivery issues to consider:

- Audience size & distribution
- Media richness (motion handling, visual clarity/pixel resolution
- Availability of existing technological infrastructure
- Portability (wireless)
- Capital & recurring costs
- Hardware endpoints (VTC equipment/satellite receivers/servers)
- Display devices (TVs/monitors)
- Bandwidth (WAN/LAN connectivity: one-way data vis-à-vis 2-way data)

The dissemination of content through the use of instructional media is only as effective as the quality of the instruction. Regardless of the learning environment, instruction is designed to transfer knowledge from the instructor to the learner to the real-world environment. To that end, the transfer of knowledge is facilitated by the development of effective instructional strategies.

How does this reality influence media selection and choice of instructional strategies? Quite simply, certain synchronous instructional technologies such as satellite e-learning, video teleconferencing, and synchronous web-based instruction, are best suited for instructional strategies that require a live and dialectic learning environment. Conversely, there are asynchronous instructional technologies that are best integrated with strategies that require asynchronous learning environment.

To that end, instructional strategies have proven to be effective in facilitating the transfer of learning, and because in any given program of instruction there are multiple learning objectives, it follows that finding the right medium-to-objective match will likely result in a blended media approach. Consequently, the tables below represent common classroom instructional strategies mapped to synchronous and asynchronous instructional media.

Instructional Strategy

The term instructional strategy suggests a huge variety of teaching/learning activities, such as group discussions, independent reading, case studies, lectures, computer simulations, worksheets, co-operative group projects, etc. These essentially are *microstrategies* that represent pieces of an overall *macrostrategy* which take learners from a motivational introduction to a topic through learners' mastery of the objectives (Dick, et al, 2009).

A *macroinstructional* strategy (the complete instruction) is created when an instructional designer/ teacher does everything to bring about learning, i.e., define the objectives, write the lesson plan and tests, motivate the learners, present the content, engage the students as active participants in the learning process, and administer and score the assessments (Dick, et al, 2009). Consequently, when designing instruction, it is necessary to develop an instructional strategy that employs the knowledge we have about facilitating the learning process.

Instructional Learning Strategies

Transfer of learning means that something learned in one situation can be applied in another. Since transfer is the primary goal of instruction, it is imperative one must design for transfer. To that end, transfer is facilitated by the development of instructional strategies.

Instructional strategies focus on the delivery of knowledge, while cognitive strategies focus on how the learner processes the knowledge. Instructional strategies describe the general components of a set of procedures used to enable students' mastery of learning outcomes, and are developed in support of the instructional goal and specific learning (instructional) objectives.

Scholars have identified learning to be primarily a social, dialogical process. Social learning theory suggests that most learning takes place in a social context where learner behavior is modeled by others. This modeling can occur through lecture, guided discussion, role-playing, case study, and other instructional strategies. To that end, student activities are the product of an instructional strategy that facilitates the attainment of the instructional objectives.

Examples of instructional strategies are (see Table 1 for definitions):

- Lecture
- Demonstration
- Role Playing
- Guided Discussion
- Brainstorming
- Case Study
- Simulation
- Games & Gamification
- Modeling

Figure 7: Synchronous Media Mapped to Instructional Strategies

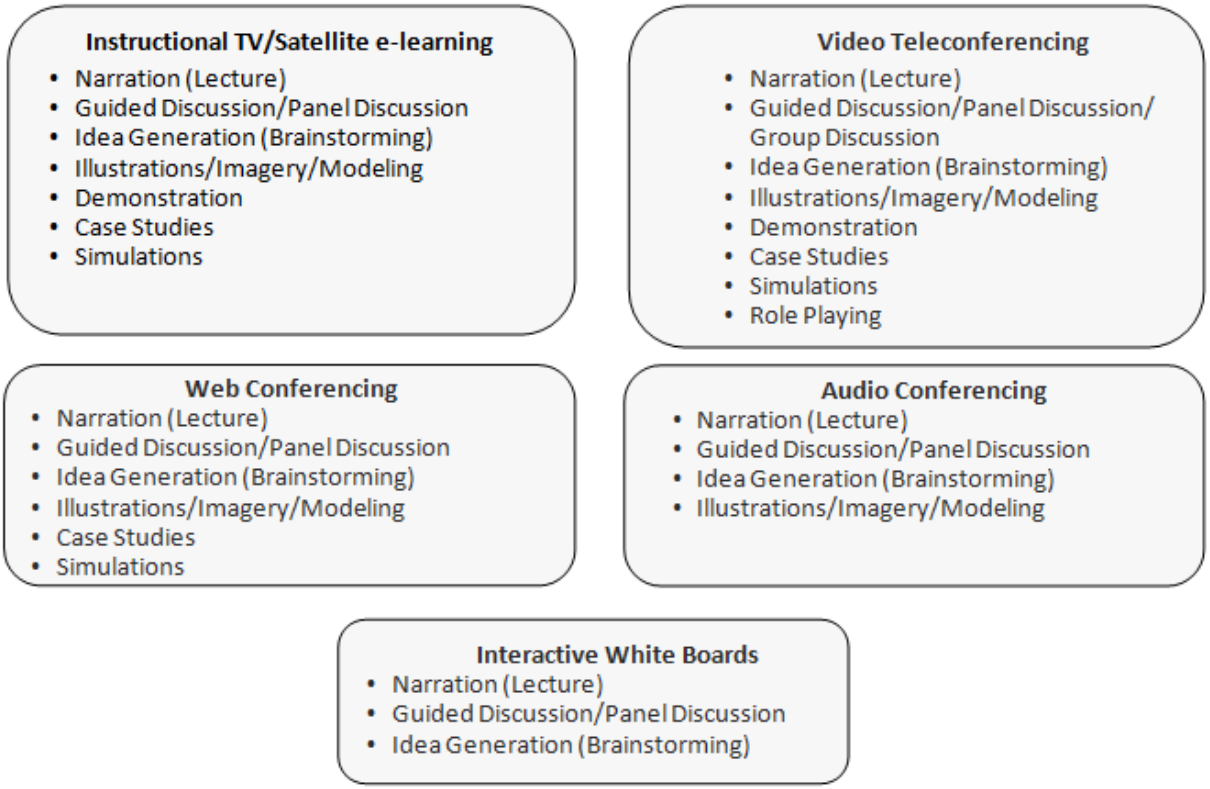
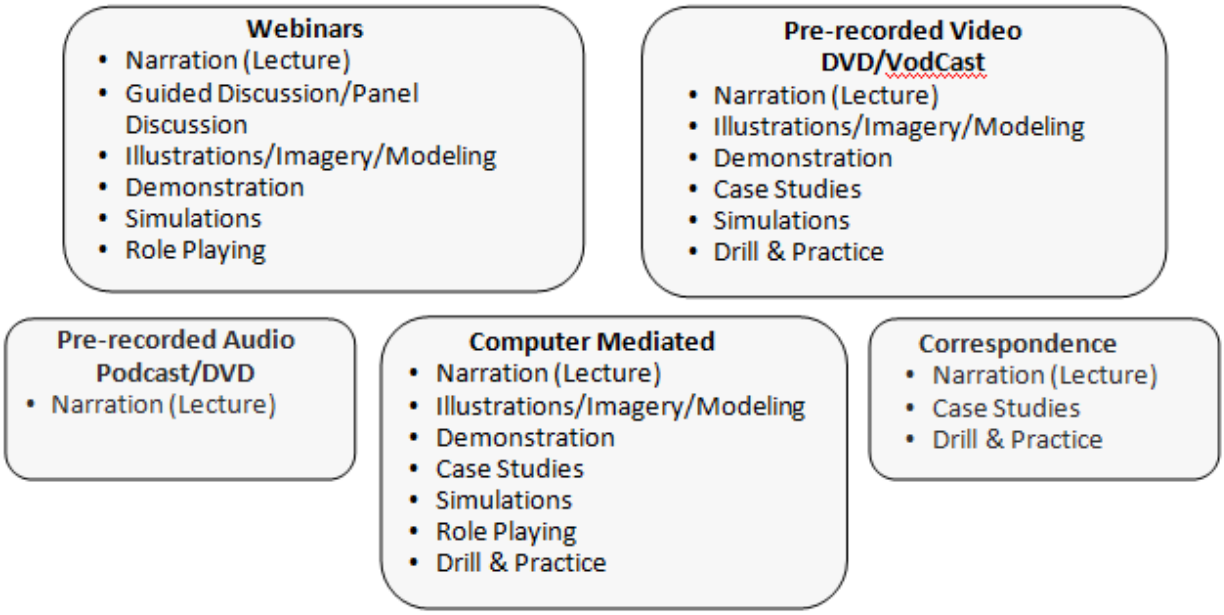


Figure 8: Asynchronous Media Mapped to Instructional Strategies



Cognitive Learning Strategies

While instructional strategies focus on the transmission of knowledge and describe the general components of a set of procedures used to enable student mastery of learning outcomes, cognitive learning strategies are methods used to help learners link new information to prior knowledge (Driscoll, 2005). To that end, cognitive strategies focus on how the learner processes knowledge and provides a structure for learning through mental strategies, and these are used to facilitate the activation and retention of prior knowledge by integrating active and exploratory learning techniques into the design process. Consequently, cognitive learning strategies focuses on how the learner processes the knowledge and supports the learner as they develop internal procedures that enable them to perform tasks that are complex, and can increase the efficiency with which the learner approaches a learning task (Driscoll, 2005).

The utility of cognitive learning strategies can be employed by trainers and/or instructional designers to facilitate the activation and retention of prior knowledge by focusing on *knowledge construction*. Since cognitive learning strategies primarily focuses on how the learner processes the knowledge, it provides a structure for learning when a task cannot be completed through a series of steps, e.g., *scaffolding*.

Cognitive learning strategies can be *represented* based on the information presented, and is used as tools to construct knowledge in new concepts (Driscoll, 2005).

Examples of cognitive strategies are (see Table 2 for definitions):

- Organizing Strategies
  - Chunking
  - Rehearsal
- Spatial Strategies
  - Frames
  - Concept mapping
- Bridging Strategies
  - Advance Organizer
  - Metaphor, analogy, simile
- Mnemonics
- Imagery

Introduction to Distance Learning

History of Distance Learning

Distance Learning has existed in the United States for more than 120 years. Not surprisingly, though, many in the profession considered it a new phenomenon due largely to the emergence of the Internet. The resulting explosion in online learning was quickly embraced throughout the education and training communities encompassing K-12, higher education, and the corporate and government sectors. Although this quote sounds as if it were referring to a new technological breakthrough, in reality, this statement was uttered by the Reverend Joseph H. Odell, D.D., delivered in November of 1910 at the dedication of the instruction building of the *International Correspondence Schools* in Scranton, PA.

> *"I do not know any innovation upon existing methods more radical and revolutionary than this"*
> *The New Era in Education: A Study of the Psychology of Correspondence Methods of Instruction*

One can follow the evolution of distance learning in the United States from the late 19th century, where it was rooted in correspondence, to the adaptation of communication media (radio and TV) in the mid-20th Century, and the application of computer-mediated instruction, and the emergence of the Internet in the latter part of the century.

In the early years of distance learning in the United States, the choice of instruction media to deliver education was limited. However, as the country grew and evolved from an agrarian society into an industrialized nation, the demand for education increased significantly. With the ensuing emergence of radio and TV, the education community quickly realized the potential of these new media and adopted them to distribute educational programs to a geographically dispersed workforce. Then, as the technology evolved, more delivery tools emerged to where the instructional designer now has a plethora of choices of media that can be used singularly or integrated to create a blended learning solution.

The Historical Timeline of Distance Learning traces the "genealogy" of distance learning by depicting its early origins to the application of communication media (technology enabled) to computer mediated and electronically assisted learning throughout the past 120 years.

Definition of Distance Learning

After the birth of the United States Distance Learning Association (www.USDLA.org) in 1989, the *Los Alamos National Laboratory* organized and sponsored the *First Annual Conference on Distance Learning (*Alexander, Andrews, Hamer, Keller, & Trainer, 1989). This conference brought together the leading distance learning professionals from throughout the United States. In attendance were representatives from higher education, K-12, state and local governments, and the Federal Government. One of the major objectives of the conference was to agree on a universally accepted definition of distance learning. The definition that emerged was elegant in its simplicity: distance learning was defined as *structured learning that takes place without the physical presence of the instructor*. This definition has been adopted by Department of Defense and the Federal Government Distance Learning Association.

Alternatively, the United States Distance Learning Association, has adopted the term *distance learning*, and defines it as *the acquisition of knowledge and skills through mediated information and instruction*. However, generally speaking, *distance learning* refers to all forms of learning at a distance, encompassing the full spectrum of instructional media—including non-electronic media—whereas *e-learning* generally refers to those learning activities that employ "electronic" technologies, and *distance education* refers specifically to learning activities within a K-12, higher education, or professional continuing education environment where interaction is an integral component.

In the years that followed the Los Alamos conference, the distance learning landscape was changed dramatically with the development of the browser and the subsequent application of the Internet to online learning. Emerging from this was a new set of terms born out of the internet: *Web-based instruction*, *Web-based learning*, *Web-based training*, *online learning*, *distributed learning*, and the most prominent new term, *e-learning*.

Just as new technologies have given rise to new distance learning applications and new distance learning environments, so have they given rise to new terms that basically refer to the same thing. Some of the more popular terms are *e-learning*, *online learning*, and *web-based training*. The mid-1990s saw the coining of the term *distributed learning*, which was quickly adopted by many organizations. Even in the

higher education community, where distance education was born, there have been revisions to the definition, to include the science of *distance teaching* and the resultant product, *distance learning*.

Distance Learning , Distance Education, and E-learning—What's the Difference?

The definition of *distance education* emerged form the academic community and has gained general consensus through its presence in leading course texts and peer-reviewed journals. As defined by American Journal of Distance Education, distance education is *institutionally based formal education where the learning group is separated and where interactive communications systems are used to connect instructors, learners, and resource* (Garrison, 1987).

Unlike *distance learning* or *distance education*, however, the term *e-learning* includes the use of instructional media technologies in its definition, hence the "e" for *electronic*. Not surprisingly, the term *e-learning* evolved not from an application, but from the emergence of the business terms *e-commerce* and *e-mail*.

Although the term e-learning was coined in 1998, the term appears to have been used as early as 1997 (Defining eLearning, 2007). Even though the term *e-learning* was defined by the Association for Talent Development (2015) as covering a wide set of applications and processes, such as Web-based learning, computer-based learning, virtual classrooms, and digital collaboration. It includes the delivery of content via Internet, intranet/extranet (LAN/WAN), audio- and videotape, satellite broadcast, interactive TV, CD-ROM, and more, the marketplace has generally accepted it as applying only to the Internet. As a result, even this term has taken on different meanings, depending on the organization defining it, and has been variously defined as:

- The facilitation of learning via electronic media or through the Internet or an intranet
- Internet-enabled learning
- Instructional content or learning experiences delivered or enabled by electronic technology

With rapid advancements in web-based collaborative tools, the next generation of e-learning emerged, e.g., e-Learning 2.0, which has been defined as *the idea of learning through digital connections and peer collaboration enhanced by technologies driving Web 2.0 users empowered to search, create, and collaborate in order to fulfill intrinsic needs to learn new information* (e-Learning 2.0—Learning in a Web 2.0 World, 2008)

> *"There is no single best model of distance learning. The quality and effectiveness of distance learning are determined by instructional design and technique, the selection of appropriate technologies, and the quality of interaction afforded to learners."* U.S. Congress, Office of Technology Assessment, *Power On! New Tools for Teaching and Learning*

It should be noted the term *distributed learning* evolved from the definition of *distance learning* but refers to only technology mediated instruction. As defined by the Department of Defense Instruction, *distributed learning* is *structured learning mediated with technology that does not require the physical presence of an instructor* (Development, Management, and Delivery of Distributed Learning, 2006).

Distance Learning Components

Given the numerous definitions of what appears to be essentially the same construct, what are the necessary and sufficient elements of distance learning? On a practical level, for an activity to be considered *distance learning* it should include—at minimum—the following:

- Physical distance between the student and the teacher – the most obvious element
- An organization that provides the content – in contrast to purely self-directed learning
- A curriculum – learning must have an objective and therefore must have structure
- Measurement of learning – without which no learning can be observed to have taken place

For a comprehensive history of distance learning in the U.S., you may want to review this article entitled Distance Education in the United States, Past, Present, Future at*:* http://distance-educator.com/wp-content/uploads/ET-article-Saba-11-12-2011.pdf

Instructional Media Supporting Distance Learning

As instructional media continue to evolve, propelled by advances in technology and fueled by the need to increase learning opportunities, the evolution and advancements of instructional media will continue to accelerate as well.

Although delivery media do not affect the content, they can affect how you design the content based upon the unique attributes of that specific medium. Media attributes are important because they may affect your choice of instructional strategies. Therefore, a set of guiding concepts should be applied when considering the most appropriate media:

- Asynchronous media are not adaptive to dynamic content
- Synchronous media can accommodate dynamic content
- Blended learning integrates multiple media with the appropriate instructional strategies, and can also include:
  - Collaborative tools used to facilitate the transfer of learning (discussion boards)
  - Adaptive tools used for dynamic content or increased interaction (blogs & wikis)

Note: While the most significant factors in student learning are quality and effectiveness of instruction, *the most important single factor in developing blended learning is the instructional objective.* The level of cognitive objectives is a critical variable to consider when selecting the most appropriate media for blended learning.

Technological Considerations & Constraints

Media are vehicles that simply deliver content. Some instructional media, however, may be *more* appropriate than others in supporting either a synchronous or asynchronous learning environment, but no single medium is inherently *better* or *worse* than another. Nevertheless, when *the most appropriate* media are selected, learning outcomes will not be affected—it is the instructional strategies employed that do.

Variables to Consider:

- Media richness (motion handling, visual clarity/pixel resolution)
- Dispersion of workforce/distribution of content
- Ability to update content quickly

- Technological infrastructure
- Capital & recurring costs
  - Bandwidth
  - Hardware end points
  - Portability
  - Simplex (one-way) data vis-a-vis duplex (2-way data)

Delivery/technical issues:

- Audience size & distribution
- Cost (In house vs. outsourcing)
- Availability of existing infrastructure
- Hardware endpoints
- Bandwidth
  - *Simplex (one-way) data vis-a-vis duplex (2-way data)*

Computer-based and Internet-based (online) Learning

Computer-based Learning

Computer-based learning is an interactive instructional experience between a computer and the learner where the computer provides the majority of the stimulus and the student responds. The computer is the storage and delivery device with all content resident on the student's computer. It provides the primary display and storage capability and can support high-resolution images and video. Computer-based learning is primarily asynchonous where the interaction is limited to the learner and the computer. To interact with the instructor or peers, computer-based learning must be supplemented by some form of synchronous instructional media.

Advantages of Computer-based Learning

Computer-based learning is not affected by bandwidth as much as other distance learning media. It can display large amounts of visual and aural information. Computer-based learning allows the use of full-motion video and high resolution graphics, and when supplemented with audio, allows users to employ the full spectrum of instructional strategies. Students can control the pace of instruction and receive immediate feedback to reinforce learning outcomes. Additionally, intervention strategies and remedial instruction can be designed into a Computer-based learning course.

Because computer-based learning is an asynchronous medium, it can promote drill and practice, which is sometimes a key strategy for increasing retention. Activation and exploratory learning strategies can also be designed into the instruction to further enhance retention. Computer-based learning is best suited to content that does not often change or require revisions. Costs of design and production can be spread across large student populations.

Disadvantages of Computer-based Learning

Computer-based learning does not provide for an unstructured, dialectic environment. Students cannot interact with the instructor by asking questions, so facilitation by the instructor is not available. Development costs may be extremely high due to numerous variables: level of interactivity, amount of visual & aural information, design of graphics and other visuals, etc. Significant annual maintenance costs can be incurred if the content changes often. Distribution efforts may require additional resources

to track distribution and ensure all students have the latest version. Media content cannot be modified or updated easily and may require an upgrade of hardware (sound card, speakers, memory, graphics card). Research has shown that reading large amounts of text on a computer screen results in a reduction of comprehension and speed when compared to print. Often used as a self-study medium, students may feel isolated and unmotivated to complete training.

Appropriate Instructional Strategies

• Narration/Description • Case Study • Role Playing • Demonstration	• Illustration • Simulation • Drill and Practice • Tutorial

Web-based Learning

Web-based learning is on-demand, online instruction stored on a server and accessed across a distributed electronic network. It can be delivered over the Internet or private local area network (LANs) or Wide Area Networks (WANs) where the content is displayed using a Web browser. Student access is asynchronous, self-paced, and does not provide for synchronous interaction between the instructor and the remote student. High-resolution images and video may be affected due to available bandwidth.

While-based learning is primarily asynchronous, web-based software and/or services delivered over the Internet can enable synchronous audio and/or video, text chat, document/application sharing, whiteboards, presentations, etc. Consequently, synchronous web-based learning can support a dialectic learning environment between the instructor and remote students at multiple locations. However, due to bandwidth limitations, high-resolution images and video may be limited.

Advantages of Web-based Learning

Web-based learning can provide consistent delivery to widely dispersed and large audiences using the Internet or an existing WAN/LAN infrastructure. The student's computer monitor becomes the primary display device, but unlike computer-based learning, the content does not reside on the student's computer but is stored remotely and accessed online.

Web-based learning can incorporate many of the features of CBI such as self-paced instruction, drill and practice, remediation and intervention. Although it is best suited for content that does not require continuous and frequent revision, it does allow content to be updated more easily than CBI because the content resides on a remote storage device such as a server.

Additionally, content and testing can be integrated with a Learning Management Systems (LMS) and "modularized" into small units of instruction suitable for assembly and reassembly into a variety of courses. Also, web-based learning can incorporate synchronous interactive technologies such as live chat rooms and instructor- originated audio that can provide instructor facilitation and feedback. Since WBI is an asynchronous technology, the student is not limited to a set time and, to a limited degree, is not restricted to accessing the content from a set place. All a student needs is a computer terminal with Internet access.

Disadvantages of Web-based Learning

Web-based learning is technology dependent, requiring Internet connectivity and a degree of computer literacy beyond basic computer knowledge. Also, bandwidth limitations can affect the design of the content. For example, dialup Internet access (narrowband) may preclude the use of video and high-resolution graphics, resulting in a predominately text-based learning module. Alternatively, courses designed with high-impact visuals or video requiring broadband access could potentially reduce the number of students who could access the module, thereby increasing costs. And, as with CBI, reading large amounts of text on a computer screen results in a reduction of comprehension and speed when compared to print. Finally, design and development, as well as annual recurring maintenance, could be significant cost factors.

Appropriate Instructional Strategies

• Narration/Description • Demonstration • Simulation • Modeling	• Illustration • Drill and Practice • Tutorial • Role Playing

Multimedia Design

In its simplest form, multimedia is the presentation of material using words and pictures. More specifically, Clark & Mayer (2011) has narrowed this definition to two forms: verbal and pictorial. Consequently, what Clark & Mayer refers to as multimedia learning is also more accurately called dual-code or dual-channel learning.

Implications for Multimedia Design in E-learning

When translating learning theory into the design of content, integrating multimedia components can lead to effective learning. Continued research into neuroscience is discovering how the brain processes information and has revealed that significant increases in learning can be accomplished through the informed use of visual and verbal multimodal learning. Our brain is constantly searching its memory for context based on prior knowledge and/or experience. In the absence of visual cues, the brain creates "mental pictures", based upon one's schema, to add context to what is printed/spoken. That said, studies have shown that *how information is presented* determines the retention level of the information. Consequently, integrating multiple media in the design and delivery of instruction would *facilitate* the learning process

Basically, humans are *multi-sensory* in that the brain performs several activities at once when processing information (e.g., tasting and smelling, hearing and seeing), but are processed through different channels in our brain. The implicit assumption is that the information gained through one sensory modality is processed in the brain to be learned independently from information gained through another sensory modality.

The human dynamics of learning is a complex process that encompasses elements of behaviorist, cognitive and social learning theories. The variables that affect learning outcomes are so pervasive that no single variable can account for variations in individual learning. Continued research into neuroscience is discovering how the brain processes information acquired through our primary learning modalities:

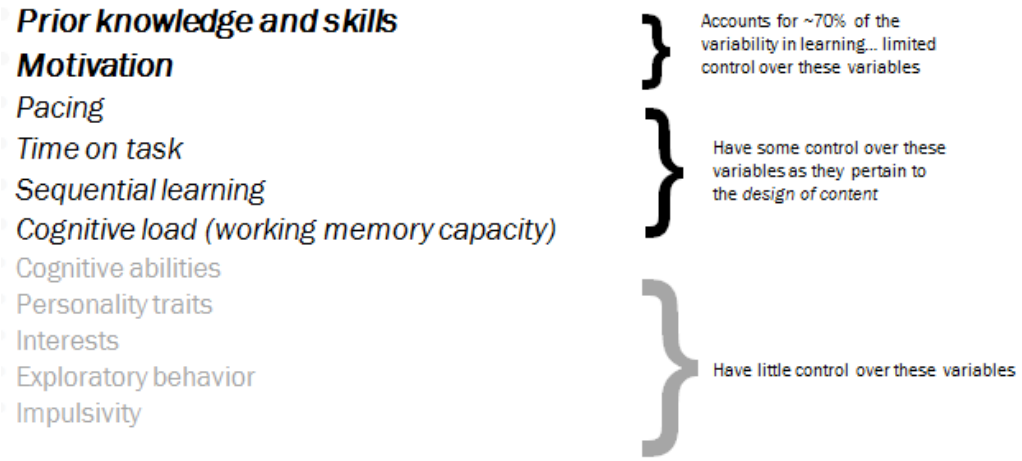
visual, aural, and tactile. However, the challenge for trainers/instructional designers is to move information from short term memory to long term memory for recall.

One of the reasons is the complexity of how the human brain functions as it relates to one's modalities in receiving information (visual, aural, kinesthetic) and how the brain processes that information (cognition). An important finding from that research is that *learning* (retention) is generally *independent of the modality* used to acquire whatever is learned. To that end, trainers/instructional designers have some control over the variables that can affect learning when designing multimedia, but there are some variables which the designer has little or no control.

You typically store memories in terms of meaning (context)-- not in terms of whether you saw (visual), heard (aural), or physically (tactile/kinesthetic) interacted with the information. Studies have shown that how information is presented determines the retention level of the information.

It often follows, then, that the more numerous and varied media used, the richer and more secure will be the concepts we develop. Studies have shown that *how information is presented* determines the retention level of the information. Cognitive science has revealed learners differ in their abilities with different modalities, but teaching to a learner's best modality doesn't affect learning outcomes. What does matter is whether *the learner is taught in the content's best modality*…people learn more when content drives the choice of modality.

Figure 9: Factors Affecting the Variability in Learning



Multimedia Design Principles for E-learning

Multimedia principle - People learn better from words and pictures than from words alone.

Modality Principle – People learn more deeply from multimedia lessons when graphics are explained by audio narration than onscreen text.

Contiguity Principle - Align words to corresponding graphics (Clark & Mayer, 2011).

- *Spatial Contiguity Principle* - People learn better when corresponding words and pictures are presented near rather than far from each other on the page or screen.
- *Temporal Contiguity* Principle - People learn better when corresponding words and pictures are presented simultaneously rather than successively.

Principles for managing essential processing (Clark & Mayer, 2011)

- *Segmenting principle*: People learn better when a multimedia lesson is presented in learner-paced segments rather than as a continuous unit.
- *Pre-training principle:* People learn better from a multimedia lesson when they know the names and characteristics of the main concepts

Principles for reducing extraneous processing

- *Coherence principle*: People learn better when extraneous words, pictures, and sounds are excluded rather than included.
- *Redundancy principle*: People learn better from animation and narration than from animation, narration, and on-screen text.
- *The Redundancy Effect* is when information is presented through different cognitive processing channels (such as text and graphic) and repeat the exact same content.
- *Signaling principle*: People learn better when the words include cues about the organization of the presentation.

Multimedia Design Theories Applicable to E-learning

Dual Coding Theory **.**Dual Coding Theory postulates that both visual and verbal information are processed differently using distinct channels within the human mind. According to this theory, the mind creates separate representations for the information processed in each channel. Both visual and verbal codes for representing information are used to organize incoming information into knowledge that can be acted upon, stored, and retrieved for subsequent use (Paivio, 1986).Consequently, when content is presented through two different channels of memory representation (visual and auditory), working memory can be increased.

Dual coding theory attempts to give equal weight to verbal and non-verbal processing in that cognition is unique and has become specialized for dealing simultaneously with language and with nonverbal objects and events (Driscoll, 2005). The theory assumes there are two cognitive subsystems, one specialized for the representation and processing of nonverbal objects/events (i.e., imagery), and the other specialized for dealing with language (Clark & Mayer, 2011). Recent research from Harvard's Medical School supports dual coding theory concepts in that presenting content in more than one way, e.g., visual and verbal, *is* helpful, *if* the information presented is complimentary and not conflicting (Kosslyn, & Kraemer, 2010).

*Cognitive Flexibility Theory***.** Focuses on the nature of learning in complex and ill-structured domains. The theory focuses on revisiting the same material, at different times, in rearranged contexts, for difference purposes, and from different conceptual perspectives in supporting knowledge acquisition (Driscoll, 2005). It is a function of both the way knowledge is represented and the processes that operate on those mental representations. The theory is largely concerned with transfer of knowledge and skills beyond their initial learning situation, and stresses the importance of constructed knowledge in that learners must be given an opportunity to develop their own representations of information in order to properly learn. The emphasis is placed upon the presentation of information from multiple perspectives and asserts that effective learning is context-dependent (Clark & Mayer, 2011).

Cognitive load theory. Cognitive load theory focuses on the strain that is put on working memory by the processing requirements of a learning task. Meaningful learning depends on active cognitive processing

in learner's working memory. If learners encounter too many elements in the presentation of multimedia information (animation, graphics, sound, text), working memory can be overwhelmed. The result is excessive cognitive load can impede learning (Clark & Mayer, 2011).

Mayer and Moreno (2003) conducted research into ways to reduce cognitive load in multimedia learning based on three assumptions:

- Humans possess separate information processing channels for verbal and visual material (Dual Channel)
- There is only a limited amount of processing capacity available via the visual (eyes) and verbal (ears) channels (Limited Capacity)
- Learning requires substantial cognitive processing via the visual and verbal channels (Active Processing)

Learning Platforms

Instructional Authoring Systems

An instructional authoring system is a stand-alone, robust software tool primarily used by instructional designers to create content. It is a high level interface that allows the author (instructional designer or teacher) to generate an instructional program without any prior programming experience. Many companies that design the instructional authoring systems offer cloud-based hosting services.

Instructional authoring systems provides a user interface (MS Office type ribbon menu structure) and simplified processes for creating screen displays, text, multimedia development (images, graphs, video, audio), learning activities, assessments, etc.) . It also provides capability for branching scenarios and different menu structures. Most authoring systems have a WSIWYG (what-you-see-is-what-you-get) preview feature, and the capability to "publish" to a learning management system, a web-page in HTML format, single file executable format, and to a CD/DVD. An instructional authoring system provides structure to the instructional design process in that it supports the design and development phases of the ADDIE model.

Examples of instructional authoring systems are Trivantis' Lectora Publisher (www.lectora.com) , Adobe's Captivate (http://www.adobe.com/products/captivate.html), Articulate's Storyline (https://www.articulate.com) , SumTotal System's ToolBook (http://tb.sumtotalsystems.com/) , and Rapid Intake, which is a cloud-based only authoring system (http://calliduscloud.com/products/RapidIntake/ .

Note: There is a small but distinct difference between an instructional authoring "tool", which basically has the capability to perform one or a limited amount of tasks. For example, Camtasia (https://www.techsmith.com/camtasia.html) is an instructional authoring tool since it does only one thing...makes flash movies. Similarly, Snagit (https://www.techsmith.com/snagit.html) is an instructional authoring tool as well, but it only does one thing...screen capture. Conversely, instructional authoring systems, like Lectora, Storyline, Captivate, etc., have the capability to perform a myriad of tasks.

Click here for Training Industry's 2014 Top 20 Authoring Tools Companies.
Click here for a list of authoring tools.
Click here for an updated list of current authoring tools

Learning Management Systems (LMS)

A Learning Management System (LMS) is an enterprise level, server-based software systems used to manage and deliver (through a web browser) learning of many types, particularly asynchronous e-learning. They generally also include the capability of tracking and managing many kinds of learner data, especially that of learner performance.

Many organizations rely on their LMS as a single point of access for all their e-learning content and student records. They are a key enabling technology for "anytime, anywhere" access to learning content and administration. These systems allow learners to register for courses. Once registered, the system will automatically send reminders to students to take a required online class. These systems allow for the management of most administrative functions. Students can check grades, turn assignments into virtual drop boxes, chat with other students, and participate in special group areas where only designated group members can enter.

Click here for Training Magazine's 2015 State of the Training Industry Report concerning LMS/LCMS usage in companies (p. 30).
Click here for the top 10 LMS by brand (2015).

Learning Content Management System (LCMS)

LCMSs are closely related to LMSs, providing much of the same functionality with the addition of content authoring. A LCMS is a learning application that deals with the development, management, maintenance, and delivery of learning materials.

The focus of an LCMS is the instructional content—its creation, reuse, management, and delivery. This contrasts with the logistics of managing learners, managing learning activities, and competency mapping provided by an LMS. In other words, an LCMS focuses on the creation of learning objects (LO) while an LMS manages the learning process as a whole, incorporating the LCMS within it.

However, both systems manage and deliver instructional content usually in the form of LOs, with an LMS being the more systemic of the two. As in the case of LMSs, LCMSs are optimized for delivery of learner-led and embedded learning strategies. Like LMSs, they can include support for facilitated and instructor-led training and education, but that is usually not their primary focus. In the simplest form, an LCMS is an LMS integrated with authoring tool and content repository functions. Content repositories are usually designed to manage many different types of content objects and generally include the following features (that are not usually found in an LMS):

- Versioning of files and/or content objects
- Ability to manage diverse and complex content object types. This includes providing navigation controls, look and feel, and a table of contents for a wide range of content object types.
- Web interface directly to the content files in the LCMS's repository
- User roles and privileges to manipulate content
- Cataloguing (through metadata tagging) and search to enable discovery of content objects and/or files

Differentiation Between an Instructional Authoring system and a LMS

An instructional authoring system allows you to create content for a specific course/learning module, while a LMS administers, manages, and tracks the training/learning function as well as the capability to

"host" the course/learning module. A LMS is an enterprise-wide software system (like an accounting/payroll system) that touches everyone in the organization while an instructional authoring system is a stand-alone software tool primarily used by instructional designers/teachers to create instructional content...that's all it does.

Instructional authoring systems" such as Trivantis' Lectora Publisher, Adobe's Captivate, Articulate's Storyline, SumTotal System's ToolBook, Rapid Intake, etc., are robust, stand-alone software tools primarily used to create instructional content. However, a LMS like Blackboard, Moodle, CourseMill, Aspen, Saba, etc., are Learning Management Systems (aka learning platforms) and are considered enterprise-wide software systems that manage the training/learning function for an organization. That said, since they are learning platforms, they do not have the capability to "author/create" content but instead can host the content created by authoring systems.

Another huge difference is the price, where instructional authoring systems cost around ~$1000-$2500, a LMS can easily cost tens of thousands of dollars and 10 times that amount in annual seat licensing fees. A LMS is an enterprise-wide software system in that it can potentially track anyone in an organization that has a training/learning requirement, hence a LMS can track thousands of employees training requirements.

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Table 1: Instructional Strategies

Instructional Strategies	Description
NARRATION/ DESCRIPTION (LECTURE)	Allows for transfer of learning through mere declaration and explication of knowledge. When interaction is available, it allows for reinforcement of behavior, spontaneous questioning, dialogue, and social interaction with immediate feedback.
DEMONSTRATION	Skill transfer through the depiction of procedural tasks, events, processes, etc.
ROLE PLAYING	Involves recreating a situation relating to a real-world problem in which participants act out various roles. Promotes an understanding of other people's positions and their attitudes as well as the procedures used for diagnosing and solving problems. Learners may assume the role of a particular character, organization, professional occupation, etc.
GUIDED DISCUSSION	Supports a synchronous, dialectic learning environment through the spontaneous and free-flowing exchange of information. Encourages active, participatory learning that supports knowledge transfer through dialogue. Students may discuss material more in-depth, share insights and experiences, and answer questions.
SIMULATION	Replicates or mimics a real event and allows for continual observation. A simulation creates a realistic model of an actual situation or environment.
ILLUSTRATION	Depicts abstract concepts with evocative, real-world examples.
IMAGERY	Imagery is the mental visualization of objects, events, and arrays. It enables internalized visual images that relate to information to be learned. Imagery helps to create or recreate an experience in the learner's mind.
MODELING	A contrived, simplified version of an object or concept that encapsulates its salient features.
BRAINSTORMING	Brainstorming is a valid and effective problem-solving method in which criticism is delayed and imaginative ways of understanding a situation are welcomed, where quantity is wanted and combination and improvement are sought. Brainstorming can occur with individuals or in a group setting, and involves generating a vast number of ideas in order to find an effective method for solving a problem.
CASE STUDY	A problem-solving strategy similar to simulation that works by presenting a realistic situation that requires learners to respond and explore possible solutions.
DRILL & PRACTICE	Repetition of a task or behavior until the desired learning outcome is achieved. Allows for transfer of knowledge from working memory to long-term memory.

Table 2: Cognitive Learning Strategies

Cognitive Strategies	Description
CHUNKING	Organization of information into meaningful units; makes it easier to use, store, and recall information; multiple chunks of information can be linked together; helps in overcoming working memory limitations; limits on the capacity of immediate memory affects the amount of information that we are able to receive, process, and remember.
REHEARSAL	Allows for mastery of manageable chunks; enhances retention of modeled events; maintains information in short-term memory indefinitely and improve recall; represents miscellaneous ways of study; activities which help put material into short term memory by keeping it active so it can be more deeply processed for recall over long periods; reviewing, asking/answering questions, summarizing.
CONCEPT MAPS	Concept mapping is a way of graphically displaying concepts and relationships between or among concepts. It allows a visual aid in which to view thoughts and ideas and can aid a student in tying ideas together or relationships between ideas. Concept mapping consists of extracting concepts and their relationships from text or other content. They are useful because they can visually depict new information and relationships which can greatly assist in understanding a body of knowledge and problem solving.
FRAMES	Frames are a visual display of substantial amounts of information; allows text easier to understand; knowledge is organized around the representation in frames and allows a uniform representation of knowledge; main ideas are represented as slots of some concept that describes properties of that concept. Can be represented as matrices or grids that allows for organizing large numbers of facts, concepts or ideas.
ADVANCED ORGANIZERS	A strategy for metacognition in that it provides a "bridge" for students to transfer pre-existing knowledge to a new topic. Advance organizers can be used to link new with something already known, an introduction of a new lesson, unit or course, an abstract outline of new information and re-statement of prior knowledge, a structure for students of the new information, and an encouragement for students to transfer or apply what they know.
MNEMONICS	Artificial aids to memory and meaningful practice which involves familiarizing oneself with a list. They act as a holding pattern while links are found to retain the information permanently. Repetition and association are two essential components to any memory technique. New knowledge is more effectively stored in the long term memory when it is associated with anything that is familiar. Demand active participation and a constant repetition of the material to be memorized.
METAPHOR	A figure of speech in which an expression is used to refer to something that it does not literally denote in order to suggest a similarity. A metaphor can be *comparative* in that it is an implicit statement that two apparently dissimilar objects do have in common features; it can be *interactive*, per se, similarities in the mind of the student between the vehicle and topic; or *relational*, per se, based on abstract connections of a logical or natural character; or an *attribute*, based on physical or perceptual similarities.

Cognitive Strategies	Description
ANALOGY	Involves taking into consideration resemblances, between objects, situations or ideas which are similar. The intent is to transfer prior knowledge from a familiar situation to a new situation, per se, use of a familiar idea or concept to introduce or define a new idea or concept.
SIMILE	A figure of speech in which two unlike things are compared and share one common factor. This form of a cognitive strategy is essential because its ability to influence learning and memory. When using a simile the relationship is expressed using “is like” or “is similar to” or “as”. A simile can use imagery as a bridge connecting the concept and the understanding, display better memory performance, e valuate their learning preference from the different formats the information is introduced, and imagine the concept, store and recall the image, and relate it to the subject.
IMAGERY	Mental visualization of objects, events, and arrays. Enabling internalized visual images that relate to information to be learned. Creating or recreating an experience in your mind. Imagery involves the primary learning modalities: visual and aural.