Instructional Technology & Theory

A Look at Past, Present & Future Trends

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What Exactly is Instructional Technology?

Before I begin my examination of past, present, and future trends in instructional technology, we should clarify exactly what we're talking about when we refer to *instructional technology*. Does it mean computers, the Internet, and software used for instruction and education? Does it include TV and documentaries, for example? Or are we focused on the human element, the resources deployed, the learner or instructor? Or is it all of the above?

Robert Reiser, professor of Instructional Systems at Florida State University, draws helpful distinctions in his 2001 article on the history of instructional design and technology: "Instructional Technology is 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."[1] The distinction between the technological processes and the actual physical media is important. For Reiser, the "soft" technologies of analysis, design, development, and management are what make instructional technology interesting, much more so than the ephemeral, ever-evolving hardware and software tools that instructional technologists use in their craft.

Instructional Technologies Timeline: 1900-2004

With this clarified definition, we can begin to survey the past, present, and future of instructional technology. The timeline in figure 1 (p. 14) shows key events, theoretical advances, media-technological innovations, and core issues in the growth of instructional technology since the beginning of the 1900's.

Clearly visible during the 20th century is the growth in complexity from the early stereographs, through to radio, film, and TV, to personal computers, CAI (computer-aided instruction), and the Internet. Spurts in progress can be seen around the time of war, when military funding led to the testing of new instructional systems. Also evident is the shift between theoretical paradigms that accounts for the use of technologies in instruction as technological, cultural, and social needs evolve.

Broken Promises

The bottom row on the timeline reveals an interesting fact about the ongoing emergence of new media and technologies. In each case, theorists found themselves asking if *this* technology would change learning and classroom practice, and many over-optimistic claims were made about the efficacy of the technology. The promise of educational TV—which prompted the FCC to allocate extensive bands of the spectrum for use by schools in the 1960's, and the Ford Foundation to finance the development of a closed circuit TV network for education and training—is but one example. Many would agree that educational TV failed to deliver on its early promise and occupies only a peripheral, underused role in most classrooms.

Similarly, in the early 1980's Seymour Papert (a renowned pioneer in the field of educational technology), like many others, saw PCs as a catalyst for "deep radical change" in the classroom, and predicted that by 1990 there would be one PC per child.[2] These over-optimistic forecasts were not borne out due to the realities of budget limitations and ongoing concerns and uncertainties about the effects of computers on learning. Moreover, software tools and hardware performance that could make computers useful and user-friendly in the classroom did not begin to emerge until more recently. Similar experiences can be recounted with other technologies earlier in the century, where an

1. Reiser, R., (2001). A History of Instructional Design & Technology: Part I: A History of Instructional Media. *Educational Technology Research & Development*, Vol. 49, No. 1, pp 53-64.
2. Papert, S., (1984). New theories for new learnings. *School Psychology Review*. 13(4), 422-428.

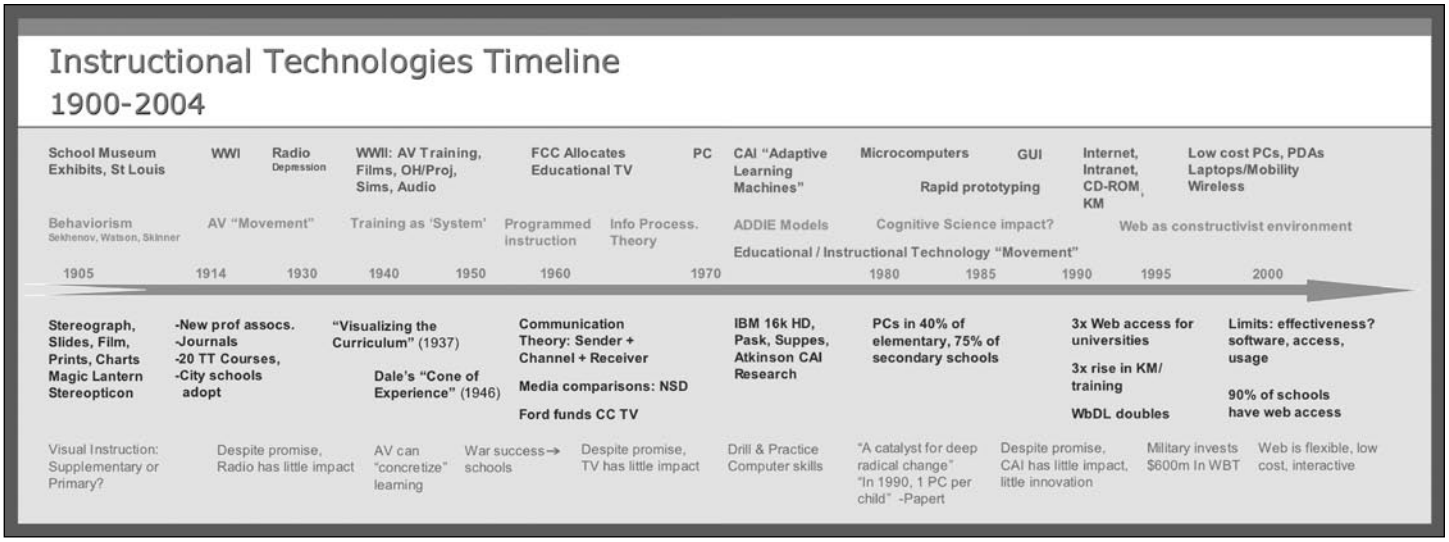

Figure 1. This timeline shows some of the most influential technologies, theories, trends, and factors in instructional technology in the last century.[3]

initial enthusiasm about a particular form of media proved to be premature once attempts were made to incorporate the technology into the unforgiving realities of the classroom. Having looked back, we can now ask: is the World Wide Web, which seems to hold so much promise for educators and learners, destined for the same disappointment and obsolescence as the Magic Lantern, educational radio, and the standalone PC?

20th Century Learning Theories 101

Before considering this question, we can find another perspective on the past, present, and future trends in instructional technology by reviewing the most influential learning theories that helped form instructional technology over the last 100 years.

There are three principal families of theories about learning: behaviorism, cognitivism, and constructivism. Behaviorism emphasizes observable behavior, rather than inner mental experiences. From our environment, we learn certain behaviors while learning not to do others. Behaviorism is also thought of in terms of association building, and the "drill and practice" software often used in skill-building is an example of behavioristic instructional technology design. Behaviorism is sometimes critiqued as being too passive and mechanistic.

Cognitivism, on the other hand, emphasizes the importance of perception, learning, and thought as bases for understanding human behavior and learning. Rooted in information processing theory pioneered in the 1960s, cognitivism draws from the analogy between computers and minds, allowing for the possibility of computer programs that "think" alongside their human users. Cognitivistic instructional design is characterized by analytic breakdown of a topic or subject matter, and the transformation of the subject matter into a set of structured cognitive tasks. Cognitivistic frameworks can include discovery tasks, problem diagnosis, and troubleshooting; Papert's LOGO-based learning tools are considered cognitivistic. In these frameworks, knowledge acquisition is seen as an active, learner-driven outcome, much more so than with behaviorism.

An even more active view of learning can be found in the theory of constructivism. In this philosophy, first described over 100 years ago, learning is seen as a process of knowledge construction where the learner is in charge of his or her own learning experience. Experience, combined with reflection and social interaction, allows the learner to build on prior knowledge and create their own understanding of ideas and concepts. An example of a constructivist learning environment online is a WebQuest, an inquiry-based activity where the information used by learners is drawn from the Web.[4] WebQuests use information to solve problems or gain deeper insights, and to support learners' thinking in terms of analysis, synthesis, and evaluation. In this way, meaningful mental models can be formed, and learners can select and integrate their own schemas in order to make sense of the world.

While behaviorism is characterized by a linear, stimulus-response approach to learning, cognitivism likens the mind of the learner to an elaborate information processing system. Constructivism, by contrast, puts the learner in charge of their own search for meaning.

The main point here is that when we survey the history of instructional media, we can see a mapping between these theories of learning

3. Timeline graphic created by the author, drawing from the Reiser article referenced in footnote 1.
4. *http://webquest.org/*

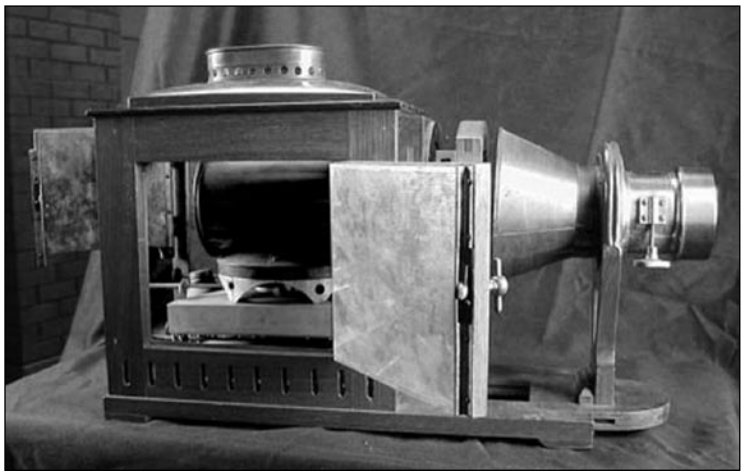

Figure 2. Will the World Wide Web one day go the way of the Magic Lantern, one of many technologies that didn't live up to their initial promise?

and the use of different types of media. For example, behaviorism, which was at its height in the first half of the last century, was complemented by linear media such as radio, film, and TV. Cognitivism, which was at its height in the 1960's to 1980's, was complemented by a new generation of desktop and personal computing, which found its ultimate expression in artificial intelligence (AI) and AI tutoring systems research.

Although behavioristic in many ways, these cognitivist systems still represented a different paradigm from both behaviorism and constructivism. Constructivism in its current incarnation is complemented by media and technologies that offer learners multiple perspectives, formats, and options for sharing and expressing their ideas. Thus, the Web, having emerged in the mid-90's, with its networked, interactive environments, accessible through portable and handheld devices, offers functionality that goes beyond behavioristic or cognitivistic worldviews, and recasts learning as a ubiquitous, experiential, self-driven activity.

The European Viewpoint

Unique economic, geographic, social, technological, and intellectual structures in the US have consistently helped give rise to revolutions in the way media is used in learning. However, across the Atlantic, European Union (EU) research and technological development in instruction—often referred to as "E-learning"—have been following a blueprint that both draws from the US experience and integrates European culture and ambitions. The focus is on cultivating improved efficiency in learning and cost-effectiveness, while deploying instructional technologies that better address the needs of individuals, groups, and organizations.

The European effort is helpful for understanding the current status and future direction of instructional technology because it leaves less to chance than the entrepreneurially driven American environment, and follows instead a more programmatic approach.

Core concepts in the vision of the future of E-learning in Europe are:

1. Universal access to open, ubiquitous, experiential, and contextualized learning materials;
2. The combination of advanced cognitive science and knowledge-based approaches with new media, including virtual and augmented reality, virtual presence technologies, and simulations;
3. The ability to learn and seek training, independent of time, place, and pace as a fundamental affordance of instructional technology that needs to be further cultivated, especially from the EU's social policy perspective.

With this sense of the theoretical background of instructional technology, and this broad vision of its future, let's focus now on the present, and on some key trends in infrastructure, content development, and research in the field.

A Vision of the Future

As more and more learning takes place online or with the support of Internet-based resources and tools, the "E" in E-learning is likely to be presumed and taken for granted. Fewer students are getting the traditional on-campus degree because of the increasing popularity of flexible online degrees. Therefore, those who want to experience "traditional" educational methods may increasingly be forced to pay a higher price.

There are also signs of increased diversification in the resources available to students. In the future, learners will likely be able to obtain degrees made up of courses and experiences from numerous providers. Moreover, mergers and partnerships of learning institutions, publishers, technology companies, and service providers and consultancies will lead to shake-ups in the ways educational institutions plan and deliver their courses. Private colleges will have to offer broader vocational options with major online components or go out of business. Many colleges, including NYU, already run successful partnerships with corporations to manage their training and education programs.

Likewise, I see the role of the professor and instructor continuing to diversify with the technology. The expectations placed on instructors regarding their digital skills have become more exacting and demanding, and the time required to respond to the steady flow of e-mail and the creation of new digital content has grown exponentially, placing increased performance pressure on faculty.

Current Trends in Infrastructure

Trends in the growth of technology for instruction can be summarized as embedding, ubiquity, specialization, miniaturization, and mobility. In this context, embedding describes how the network is becoming increasingly integrated into our urban environment. For example, web-enabled devices will continue to drop in cost, while being built into existing conventional devices. Imagine an instructor accessing her Blackboard courses via the touch screen on her broadband-connected refrigerator over morning coffee, or answering e-mail from a public web kiosk on the street while attending a conference in Amsterdam.

Another trend is the increasing ubiquity and mobility offered by wirelessly connected devices. Personal devices like smartphones and PDAs, even iPods and personal media devices, offer non-stop access to digital content and, in many cases, real-time communication and media sharing. The already ubiquitous iPod may, in the near future, come with a wireless Internet connection that would allow for potentially vast sharing of content and greatly simplified podcasting (personal radio-like broadcasting).

Furthermore, continued miniaturization, specialization, and improvements in manufacturing processes will offer consumers lower costs with greater efficiency. The so-called "m-Learning paradigm"—mobile learning—will bring with it new types of content, smarter devices, and an ever-lower cost.

With the realization of these trends will come new "vertical" organizations of social and academic interests. The Scholar search tools in Google are an early example of this trend. Likewise, metropolitan regions, institutions, organizations, and schools will see a rise in "subnetworks," that is, shared "synthetic" spaces that revolve around the ideas and communities of interest represented by, say, podcasting biology instructors, art-teaching videographers, and media-ethnographic historians.

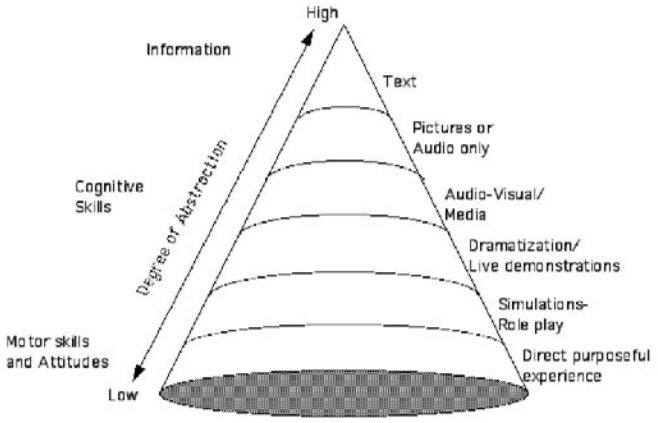

Figure 3. Edgar Dale's Cone of Experience[5] illustrates his theory on the average retention rates for different types of teaching. The further you progress down the cone, the deeper the learning and the more information will be retained.

These trends in infrastructure will require further advances in interoperability, that is, the ability of different digital platforms to communicate and exchange content. Emerging standards for accessing incommensurate digital resources include SOAP, UDDI, and XSLT. DLORN is one example of an open source, modular content repository currently being explored at NYU.

Related to this are concerns about metadata (information about digital resources that, among other things, helps search engines locate them). Metadata standards are notoriously technical and demanding, in a way that often discourages content producers from using them, rendering their content harder to find and archive. Tools for a more flexible ontology of metadata are beginning to emerge.

These types of new technologies will allow educational institutions to go beyond comparatively static learning management systems such as Blackboard. These emerging infrastructures are, however, useless without content, and trends in content development are characterized by the most interesting innovations.

Current Trends in Instructional Content

A stumbling block to the increasing diversification and ubiquity of instructional technologies has been the relative difficulty of content creation for people unaccustomed to working in a software interface. Content creation software has traditionally been the dominion of highly paid professionals working with complex, expensive software.

To date, the emphasis in web-based instructional technology has been on discoverability and use of content (e.g., Google), rather than on creation and collaborative discourse, despite many efforts to redress this imbalance. One emerging trend emphasizes bridging the "design gap" between the learner and the instructional system, so that non-experts can also create and share their resources within collaborative communities of interest. A new breed of rapid development E-learning software tools has been on the rise in the last year. These tools allow for faster, more exact, and lower cost prototyping of learning materials and content. Such tools include Macromedia Breeze, Articulate, Lersus, SNAP! Studio, Content Point, WebEx, and Mindflash.

Bridging the gap is not merely a question of designing user-friendly software, however. Increasingly,

5. Wiman, R. V. & Meierhenry, W. C. (Eds.), (1969). *Educational media: Theory into practice*. Columbus, OH: Merrill.

cognitive science has been informing the design process, and techniques are being sought for incorporating constructivist, meaningful, experiential learning into instructional content in a more systematic way. A related trend, therefore, is the emergence of basic "pattern languages" for instructional content design, which draw from content-rich and engaging experiences such as those found in simulations or games. In this vein, we can expect to see new forms of "learning browser" software that are purpose-built for the learner according to their patterns in media usage, learning cognition, and behavior.

Another trend in content development is the shift away from large, centralized instructional material projects run by media conglomerates (although these will always exist in some form) towards more grassroots, community-driven instructional content development. Technologies such as rapid development environments, as well as blogs, wikis, and revamped "push" technologies based on RSS (technically "Rich Site Summary" but sometimes colloquially called "Really Simple Syndication") put the individual and small collaborative group in a position of new power to develop compelling instructional materials without the overhead and complications that large media companies face.

Emerging Trends in Research

Behind the scenes, instructional technologists are exploring new lines of research, building the future infrastructures, content development tools, and theoretical frameworks which will define the field in the decades to come.

As previously mentioned, an increasing role is being played by the cognitive sciences in helping to build a foundation for web-based learning. As knowledge about learning processes and cognition evolves, so will its application to the field of instructional technology. Knowledge construction, the formation of mental models and conceptual structures, and their relationship to navigation and interface design will continue to be researched. Methodologies and techniques for evaluating the effectiveness of web-based learning will become essential as educational institutions need to justify and rationalize their expenditures.

Web-specific learning activities such as collaboration, communication, and gaming will be researched alongside new types of interaction that lead to more authentic tasks, an improved sense of social presence, metacognitive mapping, and insights into how learners manage complexity. Individual differences among learners (e.g., visual versus spatial; linear versus holistic) can now be accommodated very well by modern computers; however, we still lack the tools for determining and catering to individual differences in instructional content. New dimensions of individual differences will be researched with their specific interaction sets, leading to improved, more effective personalization for learners. Issues in policy, and social, economic, and philosophy will also be explored in an attempt to make sense of the broader cultural consequences of instructional technologies.

Conclusions

After a series of fits and starts in the 20th century, the current trends in instructional technology can be characterized by continued uptake of the technologies, increasingly ubiquitous access, diversification in content creation, infrastructure, and communities of use, and mobility in learning. The creation and sharing of learning experiences will become easier for non-experts, while large education-dependent organizations and institutions will experience almost constant shake-up as a result of the pressure to adapt to new technology. The role of cognitive science in informing design and research, as it applies to individuals as well as to collaborative groups, will grow in importance.

Our review of these trends brings us back to the concern about the lifespan of new technologies. With the historical perspective gained from previous technologies such as radio, film, and TV, we can see that the promise of new media can fade out as people realize its limitations. The question to ask, then, is: won't the same disappointment occur with the web-based technologies reviewed in this article?

While it is true that this could happen, there are no signs thus far. Instructional technology survived the bursting of the Internet bubble intact, for example, and continues to grow. When we consider the learning theories discussed above—behaviorism, cognitivism, and constructivism—it's evident that the Web offers a new set of affordances that are no longer one-way, passive transmissions of content, but rather, two-way, interactive environments that allow for learners to explore multiple perspectives, in multiple formats, in a way that suits them and puts them in charge of constructing their own learning experiences. Only time will tell if the Web can offer a truly effective constructivist learning environment, but at least for now, the future looks bright.

Links

- Technology and Learning in 2005: *http://www.nyu.edu/its/ftc/ls/future.html*
- Instructional Technology Theory Database: *http://tip.psychology.org/*
- E-Learning Europe Program: *http://www.elearningeuropa.info/*
- EDUCAUSE: *http://www.educause.edu/*
- Podcasting: iPod Therefore iPodcast: *http://www.nyu.edu/its/ftc/ls/podcast.html*

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