8 The Impact of Technology and Theory on Instructional Design Since 2000

Scott Joseph Warren, Jennifer Lee, and Anjum Najmi

Abstract

The impact of shifting epistemologies in the field of instructional design during the last century has had a major impact on how we design instruction. The goal of this chapter is to provide an overview of important shifts in ideas about what knowledge is, how it can be produced or constructed, and what it has meant for instructional design in the last decade. We discuss how technology has influenced instructor, learner, and designer beliefs about knowledge, instruction, and learning. Furthermore, we look at the changing landscape of theory and research that supports and questions these perspectives, and the implications it has on instructional practices.

Keywords

Conceptual age learning • Multiuser virtual environment • Epistemology

Introduction

Systematized models and theories of instruction can be traced as far back to pre-Socratic times of the Elder Sophists. Early educators such as Comenius, Pestalozzi, Herbart, and Montessori developed their own instructional models (Saettler, 1990; Jonassen, 1996). Since the early twentieth century, instructional design has moved through four stages, each being built on the previous one and each of them being characterized by a specific focus, theoretical assumptions, and practical implications (Winn, 2002). According to Winn (2002), the Four Ages of Educational Technology are the Age of Instructional Design, the Age of Message Design, the Age of Simulation, and the Age of Learning Environments. We will discuss how the four ages were guided by different philosophical assumptions that shaped how we design instruction, implement learning, and determine assessment.

For the purposes of this chapter, we define instructional technology according to Seels and Richey (1994) as "the theory and practice of design, development, utilization, management and evaluation of processes and resources for learning" (p. 1). While almost two decades old, this characterization manages to provide a succinct description of the field, without excluding the innovations that have come since that time. Winn proposed that current instructional design research should focus on learning environments that integrate technological innovations. Some of these include (1) artificial learning environments, (2) communication tools used to foster social interaction, (3) distributed cognition in the form of communities of practice, and (4) integrated or "complete systems" (Winn, 2002, p. 343). These technologies include high-level graphic representations of users in three-dimensional learning environments, synchronous and asynchronous communication tools, and Web-based instructional materials for guiding students to research and other learning materials.

This focus on learning environments fits well in the US public schools today. In these environments, there is call for

S.J. Warren
College of Information, University of North Texas, 3940 N. Elm, Suite G150, Denton, TX 76207, USA
e-mail: scott.warren@unt.edu

J. Lee (✉) • A. Najmi
University of North Texas, 3940 N. Elm, Suite G150, Denton, TX 76207, USA
e-mail: Jennifer.Lee@unt.edu; an0091@unt.edu

J.M. Spector et al. (eds.), *Handbook of Research on Educational Communications and Technology*,
DOI 10.1007/978-1-4614-3185-5_8, © Springer Science+Business Media New York 2014

shifting toward a new paradigm for learning. This is one that takes advantage of advances in technology that have been made for more than a decade. We argue that instructional design has entered a fifth age, the Age of Conceptual Learning, which was predicted nearly two decades prior:

> Technology will play central roles in teaching, assessment, and keeping track of learner progress…computer-based simulations will be excellent tools for modeling the real-world, authentic tasks and for maximizing active involvement and construction of learning. Multimedia systems will integrate computers and interactive video. (Reigeluth & Garfinkle, 1994, p. 67)

Such advances that were once viewed as a part of the future, are now at the forefront of many technology integration efforts in both K-12 and higher education settings. However, much past and current research focuses on whether learning improves, as measured by standardized tests, from the use of particular technologies. This is as opposed to studies that examine how the use of technology can transform learning environments to address higher order thinking skills and teach advanced concepts (Christensen, 2002; Guzman & Nussbaum, 2009; Zhao, Pugh, Sheldon, & Byers, 2002). Topics such as how a technology-supported learning environment increases student critical thinking ability, creativity, organizational ability, or research skills are now being explored. However, much research remains focused on teacher perceptions of technology integration rather than teaching high-level skills with technology as tool rather than as central facet of instruction (Gorder, 2008; Makki & Makki, 2012; Yanchar & Gabbitas, 2011). Throughout the chapter, we discuss how new research findings affect the state of instructional design today. In the next sections, we examine how the four ages of educational technology have led to the Age of Conceptual Learning.

Age of Instructional Design

In this section, we present the four ages of instructional design as distinct from one another in terms of theoretical frameworks, foci, and methods. While this is a necessary oversimplification to delineate the unique characteristics associated with each age, the four ages chronologically overlap as one paradigm begins to take hold as another recedes. This is not to say that vestiges of older paradigms do not continue to exist in daily practice. Many instructional designers today first learn rudimentary instructional design methods from older paradigms to gain prerequisite knowledge regarding how to design from different perspectives, as clients may desire one or another. Further, one must understand the rules of a prior paradigm before one is qualified to break them. Knowing where we have been as a field is important as we seek the future of design.

The Age of Instructional Design, which focused mainly on content creation, was based on behaviorist and cognitivist theories of learning. Learning was perceived as simply a change in behavior or cognitive structure or both with instruction designed to effectively transfer knowledge to the learner. This age was heavily influenced by the curriculum reform movement of the 1950s and specifically Tyler's (1949) linear model of instruction (Jonassen, 1996; Saettler, 1990). This included the mechanisms of scientific management emphasis and focused on both standardization and increasing learning efficiency through content and task analysis. The instructional model follows the sequence of input–process–output and its goal is to construct a comprehensive plan of instruction. Such designs presume that optimal conditions for learning primarily depend on defined learning process goals. As such, analyzing the goals of education is expected to allow instructional designers to devise methods for the achievement of these goals (Mager, 1997; Smith & Ragan, 2005). Through content and task analysis, the designer and teacher identify specific prerequisites and skills needed and select the tasks the learner should complete to achieve the specific learning outcomes (Saettler, 1990; Jonassen, 1996; Vrasidas, 2000). The approach leads to emphasis on content structure and analysis techniques and to the presentation of information (Dijkstra, 2005).

Several instructional models and learning taxonomies have followed this approach and each has made significant contributions. These have included theoretical frameworks provided by Gagné and Merrill (1990), Piaget (1972), Bruner (1990), Bloom (1984), and Ausubel (1978) among others (Cennamo & Kalk, 2005). The combination of behavioral and cognitive theories of learning gave rise to the systems approach of instructional design, which was an effort to design a complete program to meet specific needs and objectives (Reigeluth, 1999). Technology was perceived as a means to boost performance and support programmed instruction representing mastery learning, drill and practice, and convergent tutorial programs (Jonassen, 1996). Task analysis was the main method for determining content organization and instruction was to be planned, designed, evaluated, and revised (Winn, 2002).

Age of Message Design

The Age of Message Design emphasized instructional format rather than instructional content. In this era, the instructional designer and the learner had greater control over learning material than in the instructor-directed paradigm that preceded it and students with different skills and abilities were recognized to learn differently from different instructional treatments (Cronbach & Snow, 1977). During this time, pedagogical foundations emphasized how an environment was designed and its particular learning affordances were made available in conjunction with an underlying psychological model. The challenge for instructional designers working in the design of instruction has been to regulate philosophically informed principles, take advantage of technological capabilities, and to look beyond "the assumption that the format of the message alone determines the level of encoding in memory" (Jonassen, 1996, p. 317).

The basis for learning in this model is what John Dewey (1943) identified nearly a century ago as the greatest educational resource—the natural impulses to inquire or to find out things; to use language and thereby to enter into the social world; to build or make things; and to express one's feelings and ideas. Dewey saw these impulses rather than traditional discipline as the foundation for curriculum, to be nurtured for lifelong learning. The focus shifts from the features of hardware or software and instead to the user or the learner, which serves as the starting point for instructional design. Instruction centers on understanding and meaning making, with a focus on the analysis of learning processes, in particular on the way technology alters environments for thinking, communication, and action. The interactive, multimedia capabilities of the computer (i.e., sound and graphics) account for individual learning differences, individual aptitude, and learner preferences. Hence, the term "message design" evolves with both the media and the learner. Flexibility of technology provides designer and learner greater control over the learning process.

The social constructivist paradigm. Social constructivists assert, "knowledge is individually and socially constructed by learners based on their interpretations of their experiences in the world" (Jonassen, 1999, p. 217). Drawing upon foundations of situated cognition (Brown, Collins, & Duguid, 1989), context is critical in influencing how information is processed, negotiated, and used, as well as how understanding evolves. Lesson content and heuristics for performance are seen as best embedded or situated within an authentic task. As such, learning activities are interpreted by each learner rather than only an external agent such as an instructor (Brown & Palincsar, 1989). Technology and other instructional aids scaffold performance, making complex tasks more manageable without simplifying the task itself (Glaser, 1990; Vygotsky, 1978).

The goal is to cultivate the learners' thinking and knowledge construction skills. Learning becomes an act of critical and creative thinking. Accompanying instructional design principles include:

- Embedding learning in complex real-world problems
- Providing rich and flexible learning environments with goals and objectives set by the learner
- Including continuous assessment embedded in the instruction
- Detailing an evaluation which gives feedback to both learner and teacher

Multiple perspectives and social negotiation are integral parts of learning (Jonassen, 1992) in this paradigm. The overarching goal is to encourage manipulation rather than simple acquisition, and to root the learning process in concrete experiences.

Age of Simulation

As the Age of Message Design faded, the Age of Simulation emerged in response to the wide availability of technologies that allowed for the development of digital models that students could directly experience, which encouraged interaction that is learner centered. We adopt Saunders' (1987) definition of simulation in that they are "a working representation of reality … [that] may be an abstracted, simplified, or accelerated model of process" (p. 9). These tools nurture individual learning and understanding, rather than teach explicitly (Olson, 1988). Dewey (1933, 1938) perceived schools as settings in which students received life apprenticeships. Thus, interest in environments that immerse individuals in authentic, reality reflecting learning experiences, where the meaning of knowledge and skills are realistically embedded, has been long standing.

Advances in technology (e.g., Internet, increased computing power) and software innovations (i.e., *synchronous/asynchronous*, *multimedia development*, *production tools*, *simulation software*) have changed the nature and breadth of learning experiences and the instructional professional's capacity to support the learners. These technologies have greatly advanced our ability to deliver instruction in different formats and in different ways. Learning systems of enormous power and sophistication have been developed to represent evolving notions of partnerships among learners, their experience, discourse, and knowledge (Hannafin & Land, 1997).

Age of Learning Environments

Winn (2002) stated that the next paradigm shift in the field would be the Age of Learning Environments. This was an expected product of the shift from the design of instruction to the design of learning environments with learning being more dependent on the learner. Such environments cognitively and/or physically situate content and skills within complex, adaptive educational scaffolding spaces both face to face and online. From an instructional design perspective, we argue that the advances made during the Age of Learning Environments were crucial in paving the way for the current Age of Conceptual Learning. Winn's argument has been borne out with a transformation of learning environments in the last from face-to-face classrooms to online, distance-delivered courses now ubiquitous across the United States and the world.

Keefe and Jenkins (2000) categorized learning environments into three distinct periods: traditional, transitional, and interactive. Traditional learning environments were "based on nineteenth-century factory models, scientific management, the behavioral research of Thorndike and Skinner, and the learning hierarchies of Gagné and Bloom" (p. 6). According to Keefe and Jenkins, transitional learning environments came about as attempts to improve the behaviorist classrooms by emphasizing individualized instructions and group-based mastery. They go on to note that, during this period, several benchmarks were used to measure school effectiveness including test scores, attendance, completion rate, and school ratings. However, the authors contended "the movement failed to move schools toward authentic and reflective environments that the new century seems to demand (p. 10)." As a result of this failure, Keefe and Jenkins further argued that a third period called the interactive learning environments emerged to meet the needs of the next generation of learners.

Keefe and Jenkins (2000) also stated that the purpose of interactive learning environments is "to involve students and teachers in a total learning experience. Who and what define(s) a total learning environment? We argue that the definitions are different for different learners" (p. 12). To wit, Winn (2002) stated "learning environments can either be entirely natural, or they can be artificial, existing only through the agency of technology" (p. 335).

There are two reasons why artificial learning environments were proposed as beneficial by Winn. First, he asserted that artificial learning environments help people avoid the dangers associated with learning in the natural environment. Flight stimulation and army combat training come to mind as examples where the artificial learning environment provides an alternative to the real ones and have been used to train both pilots and soldiers (Nieborg, 2005; Schneider, Carley, & Moon, 2005). Secondly, Winn proposed using artificial learning environments such as digital simulations to show a child the concept of friction through a rolling virtual ball or may provide interactive demonstrations of Newton's Laws of Motion.

Interactive learning environments have been at the forefront of many research agendas including projects such as *River City* led by Chris Dede, *Quest Atlantis* under the direction of Sasha Barab, and other emerging projects funded by the National Science Foundation. Additionally, the National Institutes of Health have long funded research into the use of virtual environments to help treat psychological and addiction disorders (Anderson, Zimand, Schmertz, & Ferrer, 2007; Bordnick, Copp, Brooks, Ferrer, & Logue, 2004; Bordnick, Copp, Traylor, Walton, & Ferrer, 2009; Bordnick et al., 2008). Researchers have also explored the use of Second Life, a 3D virtual world in education, finding some benefits to learning from providing learners with advanced models with which they can interact (Brown, Gordon, & Hobbs, 2008; Derrington & Homewood, 2008). Bares, Zettlemoyer, and Lester (1998) proposed that 3D learning environments enable "learners to participate in immersive experiences" that help them "develop a deep, *experiential* understanding of highly complex biological, electronic, or mechanical systems" (p. 76–77).

Dawn of a New Age: The Age of Conceptual Learning

Winn (2002) reminds us that:

> as our technologies become more able to bring information, learning materials, even learning environments to whenever people to be, the argument can be made that we no longer need to remember what we need to know; we can simply call it up and display it when it is needed. Whether this trend spills over into the world of education to any great extent is unclear. If it does, then the impact on traditional curricula will be tremendous. (p. 348)

In a similar vein, Pink (2006) argued that we are moving from the Information Age to the Conceptual Age. He goes on to add that the future belongs to a new breed of empathizers, pattern recognizers, and meaning makers. Today, one of the biggest criticisms of instructional design is that instruction created from older paradigms does not prepare students for the real world. Many of us are still held fast in the era of traditional or transitional learning environments.

As we shift to a new Age of Conceptual Learning, a determination must be made of what a learning environment that includes these characteristics should look like. Spector (2010) suggested the shift as a reconceptualization of learning rather than the reinvention of learning itself. Current research often focuses on systemic change of school learning environments themselves, as well as the use of instructional technology to develop or expand alternative learning environments. This is instead of exploring how technology and curriculum can be aligned to merge the needs of the Industrial Age or the Information Age paradigms with what is currently available. However, a number of questions remain regarding the emerging concepts of what constitutes a comprehensive learning environment and how contemporary technologies and/or technology-supported learning environments and their complementary instructional methodologies may be used to support them.

In the context of this chapter, technology-supported learning environments are those that employ tools such as computers, distance learning equipment, Internet resources, or other comparable hardware or software in order to improve student understanding.

This notion is comparable to Winn's (2002) concept of an artificial learning environment or Grabinger's (1996) notion of a rich environment for active learning (REAL). The use of such environments is increasingly prevalent as the availability of technology in K-12 schools increases through access to online forums, educational games and simulations, and integrated digital learning environments (Squire, 2008). In the next section, we examine several trends that emerged last decade and how they have redefined instructional practices today.

Major Development: The Learning Sciences

An important development in the aughts was the establishment of the learning sciences. As with other paradigms, the learning sciences drew some inspiration from both the previous decade and fields outside of education such as cognitive science, psychology, neuroscience, computer science, engineering, and linguistics. Soon after, the Cognition and Technology Group at Vanderbilt (1990, 1993, 1994) experimented with situated cognition and anchored instruction at Vanderbilt with Jasper Woodbury and laser disc-delivered instruction. Ideas such as situating learning in context (Barab et al., 2007) and anchoring learning within narrative and ill-structured problems (Jonassen & Hernandez-Serrano, 2002) have supported later developments such as learning games (Kafai, Quintero, & Feldon, 2010; Squire, 2006), advanced forms of problem-based instruction to support science learning (Kolodner, 2002; Walker & Shelton, 2008), and multiple forms of literacy (Steinkuehler, 2007, 2008; Warren, Barab, & Dondlinger, 2008). In 1999 and 2000, the National Research Council released *How People Learn* and its companion text *How People Learn*: *Bridging Research and Practice*, which combined to outline not only the theoretical model of the learning sciences but also how the model would be implemented in classrooms and its efficacy researched.

Instructional Design from 2000 to 2010

During this period, several learning environments have been of special interest. These include computer-assisted language learning (CALL) environments, mobile learning, multiuser virtual environments, and games and simulations designed to support learning concepts and or practicing science, mathematics, and language arts skills. Each of these foci responds to the changing needs of our schools such as the large increase of non-English-speaking students at every grade level, the recent shift in the needs of businesses from Industrial Age skills to Information Age skills, and the increase in student computer knowledge and experience with new technologies.

Table 8.1 Affordances of technology-supported learning environments

General	PBL	IBL
Frees teacher to act as facilitator (Grabinger, 1996; Hewitt, 2004)	Allows for authentic, embedded assessments and rapid feedback (Grabinger, 1996)	Allows for customized teacher and environmental feedback to address learner needs (Grabinger, 1996)
Allows for learner-control of instruction (Winn, 2002)	Has propensity for strengthening fledgling communities resolved around common practice (Wenger, McDermott, & Snyder, 2002)	Allows for embedding of simulations to practice dangerous techniques with feedback (Winn, 2002)
Allows rapid customization to learner needs (Hannafin & Hannafin, 1995)	Allows for peer feedback (M. Hannafin, Hannafin, Hooper, Rieber, & Kini, 1996)	Allows for self-directed learning using situational role-play and team-building games (Winn, 2002)
Motivational for students (Hannafin et al., 1996; Prensky, 2001)	Allows for active learning through interaction with peers to solve authentic problems (Grabinger, 1996)	Allows access to large databases to support individual and group knowledge building (Hewitt, 2004)

The use of virtual/digital environments is increasingly prevalent as the availability of technology in K-12 schools increases through online forums, educational games, simulations, and integrated digital learning environments. This is especially true in theoretical frames stemming from social constructivism such as inquiry-based learning (IBL) and problem-based learning (PBL). IBL has commonly been employed to challenge students to experiment with the world and find answers to perplexing questions rooted in science. The latter, PBL, involves learners in interacting with ill-structured problems with no single answer to construct their own knowledge and solutions. These solutions are constructed in small groups through communication and inquiry with the instructor serving as facilitator of learning rather than provider of fixed knowledge. Research-supported benefits of technology-enhanced learning environments are presented in Table 8.1.

At present, there is an emerging focus on using K-12 students in studies using digital learning environments. This primarily stems from research showing students in grade school are strongly motivated by the visual and self-regulated learning elements of digital learning environments (Foster, 2008; Tuzun, 2004), impacts on student empathy for social and other complex systems (Brush & Saye, 2003; Gee, 2004), and that they can provide strong visual models through graphical representation (Englert, Manalo, & Zhao, 2004), simulation (Aldrich, 2003; Baylor & Kim, 2005), and animated pedagogical agents (Baylor, 1999, 2002, 2005; Baylor & Kim, 2005) within designed digital learning environments that are complemented by rich face-to-face learning interactions facilitated by knowledgeable teachers (Barab et al., 2007; Warren, Dondlinger, Stein, & Barab, 2009; Warren et al., 2008).

Also during the last decade, we have witnessed the transformation of clunky cell phones into elegant smart phones. These small but powerful devices are minicomputers that are fundamentally redefining teaching and learning. Mobile learning allows us to embrace the anytime–anywhere learning model worthy alternatives to help educators, administrators, and researchers achieve the nation's vision for the twenty-first-century model of wired schools.

As developers flood the educational market with technology products, researchers must separate those that have little or no educational value from those with research-supported uses in K-12 classrooms. Spector (2010) reminded us "technology is not what learning is all about" (p. 30). This makes our research role larger than simple academic inquiry and places the researcher in a position as a shield against potentially harmful or ineffective technologies. As such, we need research-driven data to help us sieve through technologies that help advance the field and technologies that are simply available.

Game-Based Learning

Over the last few years, one major area that has emerged in education for design, development, and research is in the realm of digital games and simulations. In 2009, the Entertainment Software Association (ESA) estimated that the US computer and video game software sales generated $10.5 billion (Entertainment Software Association, 2011). Between 2005 and 2009, the industry grew at an annual rate of more than 10 %.

According to De Freitas (2006), there are four types of game-based learning: (1) educational games, (2) online games, (3) serious games, and (4) simulations. For the purpose of this chapter, games for learning are "applications using characteristics of video and computer games to create engaging and immersive learning experiences for delivering specified learning goals, outcomes, and experiences" (De Freitas, 2006, p. 3).

Beginning with such seminal games as *Math Blaster*, *Lemonade Stand*, and *Oregon Trail* in the early 1980s, the educational gaming or *edutainment* market has become massive (Slagle, 2004). Since then, digital products by companies such as *Leap Frog* have become best sellers, despite a lack of research to support their use (Dondlinger, 2007; Hays, 2005). Without such research, companies that sell products and digital learning environments may make unsupported claims regarding the educational benefits of their edutainment products.

Recently, researchers have begun exploring foundational questions about learning through interaction with digital gaming environments themselves, as well as through interactions with other participants in massively multiplayer online games (Squire, 2006, 2008; Squire & Steinkuehler, 2005; Steinkuehler, 2004). Gee (2004) believes that for games to be educational, three principles in design must be included empowered learners, problem solving, and understanding. Educational games must encourage learners to be active participants in their learning, be flexible in meeting the needs of the learners, and create a sense of identity for them.

The complexity of the digital environment, as well as the intensity of communication use to solve problems and meet objectives in video games such as Blizzard's *World of WarCraft* and NCSoft's *Lineage* series, provides a rich environment for qualitative inquiry, using such methods as computer-mediated discourse analysis (CMDA) (Herring, 2004), interviews with players, and observer participation. In a Kaiser Foundation study (2008), 97 % of the teens said that they have played games on the computer, the Internet, gaming devices, or TV; further, over half of these teenagers stated that they play games on a daily basis. This study also noted that for teens, games offer a social experience for them whether it is face to face or online.

Researchers are now examining whether gaming is educational for students (De Freitas & Oliver, 2006; Mikropoulos & Natsis, 2011; Squire, 2006). Questions such as why, when, and how learning is taking place in a digital gaming environment, the depth of cognition engaged in by learners, the social nature of learning, and player motivation for learning have implications for the design of future technology-supported learning environments.

Emerging research methods and questions. While important because of the promise of student interactivity, autonomy, motivation, and modeling potentials (Prensky, 2001; Salen & Zimmerman, 2004; Winn, 2002), the limitations of games and simulations as platforms for K-12 learning must be explored. Additionally, research regarding the educational value of console and computer games and simulations is still uncertain. The field has yet to face extensive, systematic research, so serious questions remain (Bowers, 2000; Warren & Lin, 2012). Current research has started to explore a number of important research questions such as:

1. What organizational structures in a K-12 setting represent the greatest challenge to introducing new kinds of learning environments such as those based on games and simulations?
2. Once a limitation is identified, how have successful systems been chosen and how have they implemented a systemic change process that overcame this obstacle?

3. At what point does their use begin to interfere with the larger educational, affective, and disciplinary goals of K-12 schools? Are there harmful side effects to their use in the classroom to attention span, level of independent thought, or motivation to learn without the extrinsic reinforcement of the game or simulation? Are the instructional goals and affordances of a game at cross-purposes with those in a state curriculum?
4. Are learning environments that take advantage of several computer technology affordances concurrently, such as communication tools or the ability to embed audio and video, more successful at engaging students in learning than traditional, non-digital learning environments as Gee (2003), Squire (2006, 2008), and others suggest?

This last question focuses primarily on the use of integrated, digital learning environments. Such online spaces have been built based on research on the use of games and simulations, forums, web logs, and online scaffolding as instructional tools (Barab, Warren, & Ingram-Goble, 2008; Barab et al., 2009; Warren & Jones, 2008). The combination of several different technology tools to take advantage of the learning affordances of each in an attempt to build an immersive learning environment is a next step in the use of technology to support education. It would move beyond the use of isolated technology tools and create a thematically unified experience for learners.

One attempt to create such a situation at the K-12 school level was *Quest Atlantis* (Barab, Thomas, Dodge, Carteaux, & Tuzun, 2005; Barab et al., 2009). This digital learning environment was designed to improve elementary school students' understanding of science through IBL methods in which students develop solutions to difficult, persistent environmental problems. Research studies with *Quest Atlantis* indicated improvement of student motivation and a reduction in gender differences communicated in the game environment (Barab et al., 2005; Group, 2004). New designs, coupled with stringent research, will help determine whether such complex learning environments have other benefits to learning and allow the development of guidelines for future designs.

In addition to quantitative methods, the researchers at Quest Atlantis also employed qualitative methods to describe the experiences of the learners in the learning environment. This included data collection and analysis tools such as interview, CMDA (Herring, 2004), critical ethnographic analyses (Carspecken, 1996), and case studies (Robson, 2002) in order to identify those learning experiences in the environment that make the most impact. In addition, multiple observations, teacher interviews, and document analysis were also used in order to gain additional data regarding (1) student attitudes toward using the digital learning environment, (2) student motivations for completing schoolwork in the space, and (3) teachers' multiple means of scaffolding or otherwise aiding student learning either in the classroom or in the digital environment.

Further research may result in findings that support the development of engaging educational games and simulations. Research completed at the end of the decade has already provided some guidelines for the appropriate design and use of games and simulations in or as learning environments (Dondlinger & Warren, 2009; Warren & Dondlinger, 2008; Warren, Dondlinger et al., 2009; Warren & Lin, 2012; Warren, Stein, Dondlinger, & Barab, 2009). Without such research, a number of products with problematic content or instructional methods may make their way into classrooms, resulting in reduced student learning, disciplinary problems, or other unforeseen consequences. Further, it is important that researchers make known their successful, and even unsuccessful (Baker, 2008), attempts at making games and simulations for learning so that others may replicate or improve upon those instructional designs.

Computer-Assisted Language Learning Environments

CALL is a theory of language learning that focuses on using the audio-visual, tactile, and interaction affordances of computers to improve student acquisition of second and foreign languages (Egbert & Hanson-Smith, 1999; O'Bryan & Hegelheimer, 2007). While many of these products been standalone CD-ROM-based computer programs, teachers increasingly use online learning environments to improve language learning (Bacherman, 2007; Edasaw & Kabata, 2007; Vilmi, 1999; Wimberly, 2007). One of the most common online learning environments used to support language learners in the early to mid-2000s was *Tapped In* (http://www.tappedin.org). This technology was used in English-as-a-second-language (ESL) and English-as-a-foreign-language (EFL) classrooms to allow primary language speakers and secondary language speakers to meet synchronously. During their interactions, second language speakers could clarify questions about idiom, grammar, and spelling rules, as well as discuss cultural issues relevant to learning a foreign language from a peer. Inquiry in this area is under way, but is mainly conducted by researchers in fields lacking knowledge of message design, media design, or production that would generate studies that are more valid. Of notable exception is the work of Boling and Soo (1999) in the area of CALL software design. Their chapter provides an excellent example of what our field can contribute to the study of CALL environments.

Emerging research methods and questions. Because of the use of online forums, research in the area of CALL has focused on the use of these spaces to increase student understandings of foreign culture, foreign language idiomatic use, and as a means to practice textual exchanges with native language speakers (Bacherman, 2007; Edasaw & Kabata, 2007; Kirkley, 2004; O'Bryan & Hegelheimer, 2007; Wimberly, 2007). Possible research questions include the following:

1. How does a technology-supported CALL learning environment impact the learning experience of nonnative learners as they work to improve their fluency in a foreign language, as mediated by a digital learning environment?
2. How is learning impacted when native language speakers act as peer tutors, modelers of appropriate idiom and general language use, or instructors regarding their local culture for nonnative speakers?

Research methods such as CMDA (Herring, 2004) may be useful for examining learning in such a setting. CMDA methods are used to analyze online textual interactions among learners to help identify critical periods of learning. This is especially helpful when using instant messaging, e-mail, and electronic forums as part of CALL. Quasi-experimental studies using pre- and posttests to measure changes in language fluency stemming from intervention using a CALL environment should also generate important findings regarding their effectiveness. These research methods should be valuable for measuring gains regardless of whether the learning environment consists of daily classroom use of software programs or online learning environments such as *Tapped In*.

Online environments used to support ESL and EFL learning such as electronic forums and video games such as *Where in the World is Carmen San Diego*? have been used since the 1980s to explore other conceptions of a learning environment in order to understand a foreign culture (Egbert & Hanson-Smith, 1999). This view of learning conceives of learners as central participants in the generation and sharing of knowledge in a supportive learning environment.

Conclusions

While the Age of Learning Environments has opened up new possibilities, there remain challenges and limitations faced during the era that still must be overcome. Among them: (a) K-16 are systems prone to technological fads (Cuban, 2001; Lee, 2009); (b) there remains a lack of research supporting instructor choice of appropriate emerging technologies; and (c) some instructors and administrators still resist new technologies as classroom tools (Cuban, 1988; Cuban, Kirkpatrick, & Peck, 2001).

Where is instructional design going next? What major developments of the last decade in the fields of technology, education, epistemology, and cognitive science will come together to create the next stage in our development? We believe that mobile computing is the next frontier in the field of instructional design. For far too long, we have relied on instructional design models of the past to prepare learners for the Age of Conceptual Learning. Today, learning is personal, portable, and unpredictable. As we leap from an industrial society to a knowledge society in a single generation, learning means greater flexibility, accessibility, immediacy, interaction, and collaboration. These changes have significant ripple effects on education and instructional design. Pink (2006) reminds us that early adopters may do extremely well but the rest may miss out and fall behind.

For instructional designers, this means asking what we can do *through* technology instead of what can we do *with* the technology? The answer may be deceptively simple. The Age of Conceptual Learning is about harnessing the power of the mind rather than the machines. This would require generating new ideas rather than acquiring inert knowledge and, importantly, designing instruction to teach conceptual thinking rather than only concrete facts to be repeated on a standardized assessment. It is an age when students will learn to see computers as tools that help them see and create their own bright future.

References

Aldrich, C. (2003). *Simulations and the future of learning*. San Francisco: Pfeiffer.

Anderson, P., Zimand, E., Schmertz, S., & Ferrer, M. (2007). Usability and utility of a computerized cognitive-behavioral self-help program for public speaking anxiety. *Cognitive and Behavioral Practice, 14*(2), 198–207.

Ausubel, D. (1978). In defense of advance organizers: A reply to the critics. *Review of Educational Research*, *48*, 251–257.

Bacherman, D. M. (2007). *The use of students' first language in second-language learning in a computer-based environment*. Mineapolis, MN: Walden University.

Baker, C. (2008). Trying to design a truly entertaining game can defeat even a certified genius. *Wired, 16*(4).

*Barab, S., Scott, B., Siyahhan, S., Goldstone, R., Ingram-Goble, A., Zuiker, S., et al. (2009). Transformational play as a curricular scaffold: Using videogames to support science education. *Journal of Science Education and Technology, 18*, 305–320.

Barab, S., Thomas, M., Dodge, T., Carteaux, R., & Tuzun, H. (2005). Making learning fun: *Quest Atlantis*, a game without guns. *Educational Technology Research and Development, 53*(1), 86–107.

Barab, S. A., Scott, B., Siyahhan, S., Goldstone, R., Ingram-Goble, A., Zuiker, S. J., & Warren, S. (2009). Conceptual Play as a Curricular Scaffold: Using Videogames to Support Science Education. *Journal of Science Education and Technology, 18*(4), 305–320. doi:10.1007/s10956-009-9171-5

Barab, S., Zuiker, S., Warren, S. J., Hickey, D., Ingram-Goble, A., Kwon, E.-J., et al. (2007). Situationally embodied curriculum: Relating formalisms and contexts. *Science Education, 91*(5), 750–782.

Bares, W., Zettlemoyer, L., & Lester, J. (1998). *Habitable 3D learning environments for situated learning*. Paper presented at the Fourth International Conference on Intelligent Tutoring Systems (ITS-98), San Antonio, TX.

*Baylor, A. (1999). Intelligent agents as cognitive tools. *Educational Technology, 39*(2), 36–40.
Baylor, A. (2002). Agent-based learning environments as a research tool. *Journal of Educational Computing Research, 26*(3), 249–270.
Baylor, A. (2005). *The impact of pedagogical agent image on affective outcomes*. Paper presented at the International Conference on Intelligent User Interfaces, San Diego, CA
Baylor, A., & Kim, Y. (2005). Simulating instructional roles through pedagogical agents. *International Journal of Artificial Intelligence in Education, 15*(1).
Bloom, B. (1984). The 2 sigma problems: the search for methods of group instructions as effective as one-to-one tutoring. *Educational Research*, 13(6), 4–16.
Boling, E., & Soo, K.-S. (1999). CALL issues: Designing CALL software. In J. Egbert & E. Hanson-Smith (Eds.), *CALL environments: Research, practice, and critical issues* (pp. 442–456). Alexandria, VA: Teachers of English to Speakers of Other Languages, Inc.
Bordnick, P., Copp, H., Brooks, J., Ferrer, M., & Logue, B. (2004). Utilizing virtual reality to standardize nicotine crazing research: A pilot study. *Journal of Addictive Behaviors, 29*, 1889–1994.
Bordnick, P., Copp, H., Traylor, A., Walton, A., & Ferrer, M. (2009). Reactivity to cabbabis cues in virtual reality environments. *Journal of Psychoactive Drugs, 41*(2), 105–112.
Bordnick, P., Traylor, A., Copp, H., Graap, K., Carter, B., Ferrer, M., et al. (2008). Assessing reactivity to virtual reality alcohol based cues. *Addictive Behaviors, 33*, 743–756.
Bowers, C. A. (2000). *Let them eat data: How computers affect education, cultural diversity, and the prospects of ecological sustainability*. Athens: University of Georgia Press.
Brown, J. S., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of *learning. Educational researcher, 18*(1), 32–42.
Brown, E., Hobbs, M., & Gordon, M. (2008). A Virtual World Environment for Group Work. *International Journal of Web-Based Learning and Teaching Technologies, 3*(1), 1–12.
Brown, A. L., & Palincsar, A. S. (1989). Guided, cooperative learning and individual knowledge acquisition. Knowing, learning, and instruction: *Essays in honor of Robert Glaser*, 393–451.
Bruner, J. (1990). *Acts of meaning*. Cambridge, MA: Harvard University Press.
*Brush, T., & Saye, J. (2003). *The effects of multimedia-supported problem-based historical inquiry on student engagement*, *empathy*, *and historical reasoning*. Paper presented at the American Educational Research Association.
Carspecken, P. (1996). *Critical ethnography in educational research*. New York: Routledge.
Cennamo, K., & Kalk, D. (2005). *Real world instructional design*. Belmont, CA: Thomson Wadsworth.
Christensen, R. (2002). Effects of technology integration education on the attitudes of teachers and students. *Journal of Research on Technology in Education, 34*(4), 412–433.
Cognition and Technology Group at Vanderbilt. (1990). Anchored instruction and its relationship to situated cognition. *Educational Researcher, 19*(6), 2–10.
Cognition and Technology Group at Vanderbilt. (1993). Anchored instruction and situated cognition revisited. *Educational Technology, 33*(3), 52–70.
Cognition and Technology Group at Vanderbilt. (1994). The relationship between situated cognition and anchored instruciton: A response to Tripp. *Educational Technology, 34*(8), 28–32. Retrieved from http://www.vuse.vanderbilt.edu~biswas/Research/ile/home.html
Cronbach, L., & Snow, R. (1977). Aptitudes and instructional methods: *A handbook for research on aptitude-treatment interactions*. New York: Irvington.
Cuban, L. (1988). *Teachers and machines: The classroom use of technology since 1920*. New York: Teachers College Press.
Cuban, L. (2001). Oversold and underused: Computers in the classroom. Cambridge, MA: Harvard University Press.
*Cuban, L., Kirkpatrick, H., & Peck, C. (2001). High access and low use of technologies in high school classrooms: Explaining an apparent paradox. *American Educational Research Journal, 38*(4), 813–834.
De Freitas, S. (2006). Learning in immersive worlds. London: Joint Information Systems Committee.
De Freitas, S., & Oliver, M. (2006). How can exploratory learning with games and simulations within the curriculum be most effectively evaluated?. *Computers & Education, 46*(3), 249–264.
de Jong-Derrington, M., & and Homewood, B. (2008). Get real - this isn't real, it's second life teaching ESL in a virtual world. Paper presented at the Learning in Virtual Environments International Conference, Open University, Milton Keynes. 106–120
Dijkstra, S. (2005). Cognition and Instructional Design for Problem-Based Learning. In Spector, M., Ohrazda, C., Van Schaack, A., Wiley, D (Eds), *Innovations in Instructional Technology*, 187–206. New Jersey: Lawrence Erlbaum Associates.
Dondlinger, M. (2007). Educational video game design: A review of the literature. *Journal of Applied Educational Technology*, *4*(1), 1–11. Retrieved from http://www.eduquery.com/jaet/index.htm
Dondlinger, M., & Warren, S. J. (2009). Alternate reality games as simulations to support capstone learning experiences. In D. Gibson & Y. K. Baek (Eds.), *Digital simulations for improving education: Learning through artificial teaching environments*. Hershey, PA: IGI Global.
Edasaw, Y., & Kabata, K. (2007). An ethnographic study of a key-pal project: Learning a foreign language through bilingual communication. *Computer Assisted Language Learning, 20*(3), 189–207.
*Egbert, J., & Hanson-Smith, E. (Eds.). (1999). *CALL environments: Research, practice, and critical issues*. Alexandria, VA: Teachers of English to Speakers of Other Languages, Inc.
*Englert, C. S., Manalo, M., & Zhao, Y. (2004). I can do it better on the computer: The effects of technology-enabled scaffolding on young writers' composition. *Journal of Special Education Technology, 19*(1), 5–21.
Entertainment Software Association. (2011). *2010 sales, demographic, and usage data: Essential facts about the computer and video game industry*. Washington, DC: Entertainment Software Association.
*Foster, A. (2008). Games and motivation to learn science: Personal identity, applicability, relevance and meaningfulness. *Journal of Interactive Learning Research, 12*(4), 597–614.
Gagné, R. M., & Merrill, M. D. (1990). Integrative goals for instructional design. *Educational Technology Research & Development*, 38(1), 23–30.
*Gee, J. P. (2003). *What video games have to teach us about learning and literacy.* New York, NY: Palgrave-Macmillan.
Gee, J. P. (2004). *Video games*: *Embodied empathy for complex systems*. Paper presented at the E3, Los Angeles, CA.
Glaser, R. (1990). The reemergence of learning theory within instructional research. *American Psychologist, 45*(1), 29.
Gorder, L. (2008). A study of teacher perceptions of instructional technology integration in the classroom. *Delta Pi Epsilon Journal, 50*(2), 63–76.
Grabinger, R. S. (1996). Rich environments for active learning. In D. H. Jonassen (Ed.), *Handbook of research for educational communications and technology*. New York: Macmillan.
Group, S. R. D. (2004). *Creating a socially-responsive play space for learning*: *Something for boys and girls*. Paper presented at the Annual Meeting of the American Educational Research Association, San Diego, CA.
Guzman, A., & Nussbaum, M. (2009). Teaching competencies for technology integration in the classroom. *Journal of Computer Assisted Learning, 25*, 453–469.
Hannafin, M., & Hannafin, K. (1995). The status and future of research in instructional design and technology revisited. In G. Anglin (Ed.), *Instructional technology: Past, present, and future* (pp. 314–321). Englewood, CO: Libraries Unlimited.

Hannafin, M., Hannafin, K., Hooper, S., Rieber, L., & Kini, A. (1996). Research on and research with emerging technologies. In D. H. Jonassen (Ed.), *Handbook of research for educational communications and technology*. New York, NY: Macmillan.

Hannafin, M. J., & Land, S. (1997). The foundations and assumptions of technology-enhanced, student-centered learning environments. *Instructional Science, 25*, 167–202.

*Hays, R. T. (2005). *The effectiveness of instructional games: A literature review and discussion* (Technical Report No. 2005-004). Orlando, FL: Naval Air Warfare Center Training Systems Division.

Herring, S. C. (2004). Computer-mediated discourse analysis: An approach to researching online behavior. In S. A. Barab, R. Kling, & J. H. Gray (Eds.), *Designing virtual communities in the service of learning* (pp. 338–376). Cambridge, UK: Cambridge University Press.

Hewitt, J. (2004). An exploration of community in a knowledge forum classroom. In S. A. Barab, R. Kling, & J. H. Gray (Eds.), *Designing for virtual communities in the service of learning* (pp. 210–238). Cambridge, UK: Cambridge University Press.

Jonassen, D. H. (1992). Evaluating constructivistic learning. Constructivism and the technology of instruction: *A conversation*, 137–148.

Jonassen, D. H. (Ed., 1996). *Handbook of Research on Educational Communications and Technology*. New York: Macmillan.

Jonassen, D. H. (1999). Designing constructivist learning environments. In C. M. Reigeluth, (Ed.). Instructional design theories and models: *A new paradigm of instructional technology*, Vol. 2 (pp. 215–240). Mahwah, NJ: Lawrence Erlbaum Associates.

Jonassen, D. H., & Hernandez-Serrano, J. (2002). Case-based reasoning and instructional design: Using stories to support problem solving. *Educational Technology Research and Development, 50*(2), 65–77.

Kafai, Y., Quintero, M., & Feldon, D. (2010). Investigating the "Why" in Whypox: Casual and systematic explorations of a virtual epidemic. *Games and Culture, 5*(1), 116–135.

Keefe, J. W., & Jenkins, J. M. (2000). Personalized instruction: Changing classroom practice. Eye On Education, Inc.

*Kirkley, J. (2004). Using theory-based approahces to architext online collaborative problem-based learning: Lessons learned from Monterrey Tech-Virtual University. In T. Duffy & J. Kirkley (Eds.), *Learner-centered theory and practice in distance education* (pp. 321–339). Mahwah, NH: Lawrence Erlbaum Associates.

*Kolodner, J. (2002). Facilitating the learning of design practices: Lessons learned from an inquiry into science education. *Journal of Industrial Teacher Education, 39*(3), 9–40.

Lee, J. (2009, March). Fads and Facts in Technology-Based Learning Environments. In Society for Information Technology & Teacher Education International Conference (Vol. 2009, No. 1, pp. 1957–1964).

Mager, R. (1997). *Preparing instructional objectives: A critical tool in the development of effective instruction* (3rd ed.). Atlanta, GA: Center for Effective Performance.

Makki, B., & Makki, B. (2012). The impact of integration of instructional systems technology into reearch and educational technology. *Creative Education, 3*(2), 275–280.

Mikropoulos, T. A., & Natsis, A. (2011). Educational virtual environments: A ten-year review of empirical research (1999–2009). *Computers & Education, 56*(3), 769–780.

Nieborg, D. B. (2005). *Changing the rules of engagement*: *Tapping into the popular culture of America's Army*, *the official US Army computer game*. Unpublished Study, Universiteit Utrecht, Utrecht.

O'Bryan, A., & Hegelheimer, V. (2007). Integrating CALL into the classroom: The role of podcasting in an ESL listening strategies course. *ReCALL, 19*(2), 162–180.

Olson, D. R. (1988). On the origins of beliefs and other intentional states in children. In J. Astington, P. Harris, & D. Olson (Eds.), *Developing theories of mind* (pp. 414–426.). Cambridge, England: Cambridge University Press.

Piaget, J. (1972). Intellectual evolution from adolescence to adulthood. *Human Development, 15*, 1–12.

Pink, D. H. (2006). *A Whole New Mind: Why Right-Brainers Will Rule the Future*. New York: Riverhead Books.

*Prensky, M. (2001). *Digital game-based learning*. New York, NY: McGraw-Hill.

*Reigeluth, C. M. (1999). *Instructional design theories and models* (Vol. 2). Hillsdale, NJ: Lawrence Erlbaum.

Reigeluth, C. M., & Garfinkle, R. J. (1994). *Systemic change in education*. Englewood Cliffs, NJ: Educational Technology.

Robson, C. (2002). *Real world research*. Malden, MA: Blackwell.

Saettler, P. (1990). *The Evolution of American Educational Technology*. Greenwich, CT: Information Age Publishing.

*Salen, K., & Zimmerman, E. (2004). *Rules of play: Game design fundamentals*. Cambridge, MA: MIT Press.

Schneider, M., Carley, K., & Moon, I.-C. (2005). *Detailed comparison of America's Army game and Unit of Action experiments*. USA: United States Army.

Seels, B., & Richey, R. (1994). *Instructional technology: The definition and domains of the field*. Washington, DC: Association for Educational Communications and Technology.

Slagle, M. (2004). Educational group to label video games that teach. *RedNova*. Retrieved May 10, 2004, from http://www.rednova.com/news/display/?id=56983

Smith, P., & Ragan, T. (2005). *Instructional design*. Hoboken, NJ: Wiley.

Spector, J. M. (2010). An overview of progress and problems in educational technology. *Digital Education Review, 3*, 27–37.

*Squire, K. (2006). From content to context: Videogames as designed experience. *Educational Researcher, 35*(8), 19–29.

Squire, K. (2008). Video game-based learning: An emerging paradigm for instruction. *Performance Improvement Quarterly, 21*(2), 7–36.

Squire, K., & Steinkuehler, C. (2005). Generating cyberculture/s: The case of star wars galaxies. In *Cyberlines*: *Languages and cultures of the internet*. Albert Park, Australia: James Nicholas Publishers.

Steinkuehler, C. (2004). *The literacy practices of massively multiplayer online gaming*. Paper presented at the American Educational Research Association, San Diego, CA.

Steinkuehler, C. (2007). Massively multiplayer online gaming as a constellation of literacy practices. *eLearning, 4*(3), 297–318.

Steinkuehler, C. (2008). Cognition and literacy in massively multiplayer online games. In J. Coiro, K. C. C. Lanskear, & D. Leu (Eds.), *Handbook of research on new literacies* (pp. 611–634). Mahwah, NJ: Erlbaum.

*Tuzun, H. (2004). *Motivating learners in educational computer games*. Unpublished dissertation, Indiana University, Bloomington, IN.

Vilmi, R. (1999). CALL issues: Language learning over distance. In J. Egbert & E. Hanson-Smith (Eds.), *CALL environments: Research, practice, and critical issues* (pp. 427–441). Alexandria, VA: Teachers of English to Speakers of Other Languages, Inc.

Vrasidas, C. (2000). Constructivism versus objectivism: Implications for interactions, course design, and evaluation in distance education. *International Journal of Educational Telecommunications, 6*(4), 339–362.

Vygotsky, L. (1978). *Mind in society: The development of higher psychological processes*. Cambridge, MA: Harvard University Press.

Walker, A., & Shelton, B. (2008). Problem-based educational games: Connections, prescriptions, and assessment. *Journal of Interactive Learning Research, 12*(4), 663–684.

*Warren, S. J., Barab, S., & Dondlinger, M. (2008). A MUVE towards PBL writing: Effects of a digital learning environment designed to improve elementary student writing. *Journal of Research on Technology in Education, 41*(1), 113–140.

Warren, S. J., & Dondlinger, M. J. (2008). Designing games for learning. In R. Ferdig (Ed.), *Handbook of Research on Effective Electronic*

Gaming in Education (Vol. 12, pp. 1183–1185). Hershey, PA: Idea Group Reference: IGI Global. doi:10.1145/1753326.1753637

Warren, S. J., Dondlinger, M., Stein, R., & Barab, S. (2009). Educational game as supplemental learning tool: Benefits, challenges, and tensions arising from use in an elementary school classroom. *Journal of Interactive Learning Research, 20*(4), 487–505.

Warren, S. J., & Jones, J. (2008). Yokoi's Theory of Lateral Innovation: Applications for learning game design (Special Issue on Educational Games). *i-manager's. Journal of Educational Technology, 5*(2), 32–43.

Warren, S. J., & Lin, L. (2012). Ethical considerations for learning game, simulation, and virtual world design and development. In S. C. Yang, H. H., & Yuen (Eds.), *Practices and Outcomes in Virtual Worlds and Environments* (pp. 1–18). Hershey, PA: IGI Global. doi:10.4018/978-1-60960-762-3.ch001

Warren, S. J., Stein, R., Dondlinger, M., & Barab, S. (2009). A look inside a design process: Blending instructional design and game principles to target writing skills. *Journal of Educational Computing Research, 40*(3), 295–301.

*Wenger, E., McDermott, R. A., & Snyder, W. (2002). *Cultivating communities of practice : A guide to managing knowledge*. Boston, MA: Harvard Business School.

*Wimberly, A. T. (2007). *Analyzing computer applications in English as a second language acquisition tool*. Unpublished dissertation, University of Louisiana at Lafayette, Lafayette, LA.

*Winn, W. (2002). Current trends in educational technology research: The study of learning environments. *Educational Psychology Review, 14*(3), 331–351.

Yanchar, S., & Gabbitas, B. (2011). Between eclecticism and orthodoxy in instructional design. *Educational Technology, Research and Development, 59*, 383–398.

Zhao, Y., Pugh, K., Sheldon, S., & Byers, J. (2002). Conditions for classroom technology innovations. *Teachers College Record, 104*(3), 482–515.