Exploring multimedia and interactive technologies

Desiree L. DePriest, Ph.D.

Course Developer/Multimedia Consultant/Instructional Designer

The Corridor Group

Chex eLearning

Faculty, School of Information Technology

Kaplan University

Master of Science Information Technology

Abstract

The primary goal of multimedia design strategies and innovations is to produce meaningful learning environments that relate to, and build upon, what the learner already knows and what the learner is seeking to find. The multimedia tools used to achieve knowledge transfer should activate recall or prior knowledge and then help the learner to alter and encode new structures (Morrison and Ross, 2011, p.151). Traditionally, multimedia has been localized to specific delivery systems and demographics based on the government, industry or academic concentration. This chapter explores the introduction of immersive telecommunications technologies, constructivist learning methodologies and adult learning models where instructional designers and developers are able to standardize networking and multimedia-based services and products capable of adapting a wide range of wired and wireless, established and emerging solutions that work with different devices and conditions on a global scale (Ghanbari, and Wu, et al., 2008).

KEYWORDS: multimedia, immersive media, learning, telecommunications, technologies, constructivism, active learning, adult learning, andragogy, methodologies, developers, instructional design, globalization, mobile technologies, wireless, networking, robotics, Learning Management Systems, MOOCs, Augmented reality/Mediated reality, Motion sensing input hands-free devices and touchscreen digital interface innovations & 2D/3D learning games, Mobile technologies and other hand-held technologies in the classroom and in business and innovations in science, technology, engineering and mathematics (STEM) programs, rapid application development,

Introduction

It would be virtually impossible to find a government, industry or academic environment without some form of technology today. Simple beginnings with office software have now expanded to the frequent and robust integration of multimedia tools to enhance knowledge transfer and knowledge management. Transnational businesses, online education institutions and the interdependence of governments have created a global challenge where innovations in the way we communicate are essential. Teams are no longer restricted to locality but span throughout the world while still requiring a sense of presence for best results. This has led to several of the 21st century multimedia design strategies and innovations in business, government and education. This has also led to the discovery of limitations and pitfalls in the way we network one to another in the absence of physicality using audio, video and electronic interactivity tools. As many have learned through trial, error and great expense, the ambition to produce dynamic multimedia is not as simple as buying an off-the-shelf solution and then plugging in a cord. To determine the best fit multimedia design strategy and innovation for a learning environment requires multimedia solutions that are standardized yet capable of being adapted to divergent networking technologies, wired and wireless, established and emerging, with different devices and conditions (Ghanbari, and Wu, et al., 2008). Appropriate platforms that meet the level of learner confidence have to be explored, tested and modified to fit the business mission of the institution and industry delivering the content. In the case of augmented reality, scenarios have to accurately and consistently fit 2D or 3D multimedia environments in which they are deployed. In education, business and government environments, the learning management system has to be reliable, sturdy and adaptive enough to support learner activity while maintaining congruency with goals/objectives and instructional strategies along with incorporating methods for collecting learner assessment data. Multimedia and innovative strategies must consider the learner's and facilitator's perspectives including touch screens, motion sensing input and hands-free devices to accommodate learners with special needs. Human activities worldwide are highly mobile now and businesses require on-the-go access to fit the lifestyles of the learners.

The content, no longer text-based alone, must have blended multimedia components to capture more meaningful knowledge transfer and engagement from the learners. Best fit multimedia involves the rigorous activities of integrating instructional design methodologies and models, along with the knowledge of subject matter experts and course developers, as interactivity through dynamic imaging of the course content. Constructivist learning models or various forms of active adult learning are an ideal fit for multimedia providing learners with tools to immediately apply content toward meaningful learning. The blending of content with multimedia in current fast paced environments is usually built through the use of rapid instructional design models which speed up the interaction between the stakeholder team, the time to market/implementation and learner evaluation.

This chapter will explore the following technologies:

1) Learning Management Systems and MOOCs
2) Augmented reality/Mediated reality
3) Motion sensing input hands-free devices and touchscreen digital interface innovations & 2D/3D learning games
4) Mobile technologies and other hand-held technologies in the classroom and in business and innovations in science, technology, engineering and mathematics (STEM) programs

Strategies and Methodologies in multimedia design:

1. Adult Learning Theories and the Six Principles of Andragogy
2. Constructivism
3. Rapid Instructional Design Models

Background – Modern Multimedia

The background of multimedia is extensive and could arguably begin with the Gutenberg Printing Press in 1455 or with Ben Franklin discovering electricity in 1780. For the specific purposes in this chapter, the focus is on the relatively recent background that led to web-based digital and multimedia digital technologies. These recent innovations are, no doubt, built upon the analytical machine of Lady Baron in 1833, George Boole's binary mathematical language in 1854, Bells' telephone in 1876 and Edison's phonograph in 1879. Alan Turing, 1936, creator of the "Turing Machine," capable of any calculable function and the resultant British military's first programmable electronic digital computer in 1941, all led to this day in multimedia.

A key turning point in the Western world was Vannevar Bush's keynote paper in the Atlantic, titled, "As We May Think" that envisioned the storage and dissemination of data (http://dl.acm.org, 1996). Bush was the head of the U.S. Office of Scientific Research and Development (OSRD) during World War II, and afterward, in private industry for ATT, Merck and others, he was determined to gain government support for science and technology throughout the Truman presidency years through the Eisenhower presidency.

Computing was already evolving in Europe when President Eisenhower requested funds to start the Advanced Research Project Agency (ARPA) in 1958, although the first personal computer (PC) was not created by IBM until 1981. The Disk Operating System (DOS) associated with the first PC created by Microsoft© was not multimedia but text-based only. The ARPAnet, now called the Internet, was primarily growing among the military and subsequently among a few universities for research communications only. Much development had to be done in the 40 years before the general public gained access to the Internet. Len Kleinrock, Professor of Computer Science at UCLA, wrote the first paper on packet-switching in 1961, J.C.R. Licklider & W. Clark wrote the first paper on Internet Concept in 1962, and Paul Baron's research on decentralized network topologies in 1964 was also significant (webopedia). In 1965, the first Network Experiment, directed by Larry Roberts at MIT Lincoln Lab, allowed two computers to talk to each other using packet-switching technology. This was the parent of the medium but is still no sign of multimedia; only text-based transmissions with no color communications.

Digital video technology has been developing for almost 50 years. It became available on desktops about 30 years ago and in the recent decade available on smartphones and other wireless technologies.

According to Woolf and Hall (1995):

> An early example of the educational use of digital video technology was the Palenque project co-developed by Bank Street College of Education in New York and the set of video compression algorithms that became known as digital video interactive (DVI) [Ripley, 1988]. Palenque was essentially an educational simulation based on video that enabled the user to explore the paths of an ancient Mayan site, visit the rain forest or the Mayans, and examine maps of the area or glyph writing. [pg. 2]

Computer-Aided Design (CAD) was created in 1963 along with Sketchpad (aka Robot Draftsman) using the first light pen. Philips (now Koninklijke Philips©) launched the compact audio cassette and the first home video recording. Dolby Laboratory™ soon followed in 1969 with noise reduction for prerecorded tapes. The Sony© Betamax VCR in 1975 and the JVC© VHS in 1976 were introduced commercially. In 1978, the public had its first cellphone.

Apple© unveiled the first computer to use color graphics in 1977. In 1984, Apple released the Macintosh which used graphical user interface (GUI) and a mouse. However, many experts consider the Commodore© Amiga the first multimedia computer due to its advanced graphics processing power and innovative user interface (Multimedia History, n.d.). Over time, the Amiga platform became popular for gaming and demos displaying 16.8 million colors. It was also used prominently in the desktop video, video production, and was the progenitor of other affordable video editing systems. The Amiga was the first multimedia computer to genlock; a now common technique where the video output from one source synchronizes the signals from other sources. The Amiga's native ability to simultaneously play back multiple digital sound samples made it a popular platform for early "tracker" music software. The relatively powerful processor and ability to access several megabytes of memory led to the development of several 3D rendering packages, including LightWave 3D and Aladdin 4D (en.wikipedia, n.d.).

By the late 80s, both Microsoft and Macintosh operating systems handled synchronized graphics and sound that were previously handled by separate software applications. This allowed simulated video games, like SimCity™, to gain traction. In 1988, there were 3D graphical supercomputers and in that same year, Macromedia released Director™, which allowed developers to create interactive multimedia presentations (Multimedia History, n.d.). Acquired in 2005 by Adobe Systems©, Macromedia products such as Flash™ and Dreamweaver™ drive much of the multimedia on the Internet to this day.

The initial problem for digital video was the large storage requirements for high quality which required users to save on CD-ROMs until the emergence of Apple Macintosh (MAC) "QuickTime™" digital video software in 1991. QuickTime allowed users to cut and paste video into any Mac application. The first version (QuickTime 1.x) included an animation codec suited for cartoon-type images with large areas of flat color; an Apple video codec (called "Road Pizza") was suited to normal live-action video, and a graphics codec for 8-bit images, including adding white noise to reduce distortion of low-amplitude signals (dithering). This brought about a revolution that continues to be leveraged today not only in Mac devices but QuickTime was made available on Microsoft machines in 1999. International standards (ISO) were developed for picture and video compression such as .jpeg, .gif, mp3 and mp4, which formed a solid foundation for expanding multimedia consistently in learning environments. Other software manufacturers are now interactive through digital audio/video software tools such as RealMedia™, Windows Media™ and Google multimedia™.

Entering the new millennium, immersive multimedia has grown expediently. In 2004, the number of Americans accessing the Internet with a fast broadband connection surpassed the number of slow modem users but that still left tens of millions of potential learners in limited positions to receive large video files (Cohen and Rosenzweig, n.d.). According to a 2010 Pew study, the majority of Americans believe broadband access provides a major advantage when conducting a job search, learning new skills, using public services provided by the government and getting information related to their health (Flacy, 2013). As of 2013, 30% of Americans did not have broadband access at home. This is significant for developers who publish more and more robust multimedia video, simulation and animation products. The three main multimedia video software companies are now supporting common formats like mp3 and mp4 audio/video to better meet the user's needs. Apple users can use a version of Windows Media and RealPlayer. PC users can use a version of QuickTime and RealPlayer. However, the 21st century multimedia developers' call is toward mobile-aware media devices that take into account the user's context. Multimedia developers are incorporating augmentation, simulation, and real-time streaming in addition to static audio/video content to meet the constructivist, active-learning requirements of an evolving global learning population. To accomplish this, wireless networks need to be moved out of the cellular access network to directly interact with Internet content; enabling the development of multimedia applications for the mobile device. This is a complex issue for the industry requiring legitimate 4G telephony and extension of broadband capacity to mobile network operators.

Applying a competitive strategy to multimedia tools, universities and industries are offering more online and mobile options to access education and products. Mobile is particularly stationed for success because it is inclusive of previously deemed low profit segments in society. Many of these organizations are tapping into this segment to educate them and exploit their abundant smartphone usage regardless of socio-economic status. Location, time and differences are less important now than ever before. Today's web authoring options such as Flash, HTML5, JavaScript™ and media players provide multimedia developers with the tools to integrate with learning management systems, augmentation and simulation on a 24/7 basis allowing customer access to information both wireless and broadband.

Providing the avenues for students and customers to access multimedia does not guarantee they will learn or buy a product. Multimedia must be combined with solid methodologies and strategies to meet the needs of the users.

●●●

As early as the 1940s, psychologists were interested in adult learning. Irving Lorge (1947) was in the forefront of providing a basis of fact for an adult pedagogy commensurate with the information available for the instructional methods used in elementary and high school learning environments (Teachers College Record, n.d.). He suggested that the motivation for adults to learn involved immediate or resultant gain from engaging in the process. A 1940s counterpart to Lorge, Eduard Lindeman, proposed that adults learn best when they are actively involved in determining what, how, and when they learn (Edmunds, Lowe, Murray, and Seymour, 1999).

Knowles (1984) was among the first proponents of a unified adult learning approach. The theory was based upon four assumptions:

1. As they mature, adults tend to prefer self-direction. The role of the instructor is to engage in a process of inquiry, analysis, and decision-making with adult learners, rather than to transmit knowledge.
2. Adults' experiences are a rich resource for learning. Active participation in planned experiences—such as discussions or problem solving exercises, an analysis of those experiences, and their application to work or life situations—should be the core methodology for training adults. Adults learn and retain information more easily if they can relate it to their reservoir of past experiences.
3. Adults are aware of specific learning needs generated by real-life events such as marriage, divorce, parenting, taking a new job, losing a job, and so on. Adult learners' needs and interests are the starting points and serve as guideposts for training activities.
4. Adults are competency-based learners, meaning that they want to learn a skill or acquire knowledge that they can apply pragmatically to their immediate circumstances. Life or work-related situations present a more appropriate framework for adult learning than academic or theoretical approaches. (Chapter 3, p. 1)

The first step in applying multimedia in education, government or industry is to know the demographics of the users. Traditional teaching applied to children is “jug and mug” with the big jug (the teacher) filling up the little mugs (the students), based on the limited experiences and self-direction of the demographic. A multimedia expert would rely on images and interactivity appropriate for the age and interests of those students. Adult learners have experiences in which they attribute with a level of knowing. Adults are not merely trying to learn something new; they want to build upon what they already know and integrate it with something new. Adults want to see the immediacy of the new information, how it will enhance their circumstances, in real-time. Knowles (1984) specifically provided an example of applying adult learning theory to teaching adults on the personal computer:

1. There is a need to explain why specific things are being taught (e.g., certain commands, functions, operations, etc.)
2. Instruction should be task-oriented instead of memorization - learning activities should be in the context of common tasks to be performed.
3. Instruction should take into account the wide range of different backgrounds of learners; learning materials and activities should allow for different levels/types of previous experience with computers.
4. Since adults are self-directed, instruction should allow learners to discover things for themselves, providing guidance and help when mistakes are made. (Appendix D)

Multimedia environments tightly align with andragogy due to the high level of interactivity and intrinsic increase in the motivation of the learner. Norman (1991) suggests that the design of the computer system, especially the user interface, plays a major role in making learning tasks meaningful, active and self-directed (Carroll, 1998). Zemke and Zemke (1995) cite longitudinal studies that support a window of opportunity in which adults are more receptive to learning. The study found that immediacy not only applies to the motivation to learn but also the ability to retain what is learned. It is important in multimedia design to implement innovations which provide forward-moving continuity while retaining some of the redundant functionalities in which adults have become familiar. Multimedia is responsible for its power of attracting and engaging the user to participate in the instruction. Multimedia platforms provide opportunities for review and knowledge transfer through cross-designed activities such as application exercises, knowledge checks and discussions (Zemke and Zemke, 1995). This lends an advantage to online and mobile learning for adults based on the ease of access and robust interactivity available through these platforms.

Adult learners are primarily responsible for their own learning. Learning and teaching theories function better as resources than as rules. The instructor's guidance combined with the adult's self-direction serve as a living resource in the process of learning. The multimedia provides the tangible resources and tools, functionality and attraction, to motivate learners to stay engaged and provide a positive learning environment for users to participate in the learning process. This is combined with the appropriate adult learning and constructivist methodologies and strategies.

Issues, Controversies and Problems

Learning Management Systems (LMS)

The most prevalent dilemma found to occur when creating multimedia for global learning environment is cross-platform functionality. What works for one platform does not work for all platforms. Electronic Learning Technology differs in coding depending on if it is deployed within an LMS, on CD-ROM, or DVD. Oxford University experienced this when Apple upgraded its operating system from OS X 9 to OS X 9.2.2, and yet again experienced compatibility issues with OS X 10.8. Oxford also experienced compatibility problems on systems running Win 7 OS. There was even a patch required to run the Spanish Pocket Dictionary on Linux (Oxford University Press, n.d.). The deployment of numerous multimedia learning via CD-ROMs, multi-ROMs and DVDs required the university to centralize multimedia support to add patches for learners' existing applications specific to their hardware. The constant need for emphasis on the alignment or the relationship between the multimedia design strategy and the delivery system chosen is directly tied to contextual analysis from an explicit standpoint. The delivery system should be considered as the larger environment of the learning experience. Instructional context is a collection of factors that can inhibit or facilitate instruction and learning (Morrison and Ross, p.65). The orienting context in adult learning, which addresses the learners' goals, utility and accountability for seeking the instruction, are primary considerations when designing effective multimedia. Knowledge transfer, in both adult learning and constructivism models encompasses providing the opportunities and support as well as the tools and resources that trigger a connection between the newly learned information and recognized needs in the learners' real world. The attitudinal/affective intelligence and development of the learners, essentially their motivations, precede successful learning and are sustained by ease of use and seamless design functionality. Multimedia decisions and innovations can be placed, generally, in the same category as information technology projects from the perspective that one in six of them fail due to excess spending and destroyed benefits. Other key predictors of project failures occur when the instructional designers in charge of project development do not have enough understanding of how to implement the new technology resulting in software compatibility problems (Oxford University, 2011). At the same time, when planning instruction, the desired output of the multimedia must align with the objectives of the cognitive, psychomotor and affective domains which are largely a question of emphasis and interrelationships (Bloom's Taxonomy, 1956; 1995). The equipment must be adequate to the undertaking and the designer's and developer's understanding of strategies and methodologies in multimedia are also a requirement for success.

These problems have been mitigated to some degree through centralizing instruction in learning management systems (LMS). LMS are software applications that handle all aspects of the learning process (Wikipedia). Learners sign in to the LMS and are given privileges to numerous tools and innovations to enhance the knowledge transfer. LMS have built in conferencing application capabilities, discussion forums, journals and document sharing, and gradebooks. Functionality includes chat with audio, text, & video. LMS can present documents, display computer screens and robust multimedia products. LMS have interoperable functionality with other multimedia software such as intranets and centralized repositories such as SharePoint.

Learning management systems are currently equipped to handle cross-platform functionality through standard publishing processes called Sharable Content Object Reference Model (SCORM) or Aviation Industry CBT Committee (AICC) protocol which primarily ensure accurate assessment measurements (Symons, 2011). SCORM is more widely used due to the seamless standards of communication between the LMS and the content as long as both are housed on the same server. AICC allows content to be housed on separate servers but the developer is responsible for writing all the functions of communications. Most web authoring tools such as Lectora, Articulate and Flash have single button publishing to meet the specifications of both SCORM and AICC along with other less prevalent protocols. There are certain secure environments where AICC must be used instead of SCORM which uses JS API and is not secure. If using Flash with AICC, the multimedia developer must write the communication standards and would have an easier experience using SCORM. Aside from these backend considerations, both allow for publishing a wide variety of multimedia content.

Multimedia in LMS is in support of virtual classrooms, performance-based training and just-in-time tools to create problem-based and collaborative learning. This is in distinction to didactic methods emphasizing theories of teaching but excluding theories of adult learning. Modern multimedia in adult learning also emphasizes more equality between the teacher and learner (QOTFC.com, 2007). The traditional ADDIE methodology, used by many instructional designers in LMS, is a waterfall method of analysis, development, design, implementation and evaluation. It does not have to be linear but is usually applied that way and as a result can take a significant amount of time to output. A newer model called the Successive Approximation Model (SAM) reduces revisions versus iterations through introducing a preparation phase, iterative design phase, iterative development phase and rollout (Frilling, 2013). SAM is more aligned with Rapid Prototype Design as its steps include prototyping, alpha, beta and gold processes to achieve the optimum multimedia agility. Both the ADDIE methodology and the SAM model are designed to include all stakeholders working on the content such as the subject matter experts, the multimedia developers and instructional designers, and depend heavily on innovations in multimedia within the LMS to emphasize the value of the learning process.

Augmented Reality

Designers of multimedia solutions for instruction and training are responsible for finding newer and more innovative tools to connect with the real-world and real-time needs of the learners. Augmented reality is multimedia in real-time and in semantic context with environmental elements where the information about the surrounding real world of the user becomes interactive and digitally manipulable (Wikipedia). Augmented reality fulfills the basic components of learning through layering instructions that teach and assist the users with information needed at the moment (DePriest, 2012). Educators are looking for ways to actively engage students in the learning process through incorporating some type of guided discovery that applies to the environment in which the learning exists (Mayer, 2004). Augmented reality is coupled easily with constructivism in teaching and training. The learner becomes the active creator of their own knowledge through having the experience simultaneously with the media.

Augmented reality (AR) innovations, currently making their mark in education, are categorized as markless and marked. Markless augmented reality blends with the GPS on the learners' smartphone to add locality information to the camera view (Pense, 2011, p 136). Markerless AR is further delineated as model-based tracking and move-matching. Specifically, model based tracking uses real-world points and established measurements from the coordinates from the planar environment. From each 3D video frame, a corresponding 2D matrix is designed.

The AR camera can then line-up with these points' coordinate to guide the learner. The benefits of model-based tracking are precision as long as (a subset of) the key points are visible; the system is always registering directly to the scene (Simon, Fitzgibbon and Zisserman, 2011). Furthermore, the multimedia can be made in advance for unstructured environments. It offers a businessman who is traveling to New York for the first time, standing at 49th Street & 5th Avenue, an application which will layer his smartphone camera with an augmented reality of that landscape. The user lines up the augmentation with the actual surroundings until both are seamless. Then, the application provides tags which "title" the restaurants, the tourist attractions, the police department and much more.

Bionic Eye provides information about wherever an iPhone is pointed such as local points of interest and guides the user to them.

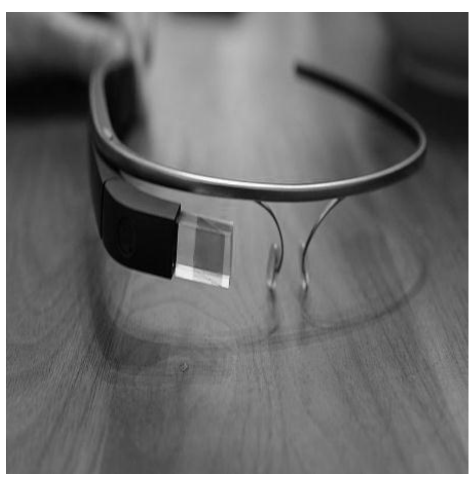
Figure 1:

Move-matching, also called structure-and-motion estimation in multimedia, offer significant possibilities for multimedia innovation in terms of precision but require a lot of manual alignment and they are slow. Second, the coordinate systems process is arbitrary usually aligning the camera with the world coordinate system (Simon and Fitzgibbon, 2011). Marked augmentation offers fully immersive multi-participant virtualization through traditional multimedia tools such as conferencing systems.

Both categories depend on making correspondence between the real 3D environment and the 2D of the augmentation. This is an innovative undertaking for the multimedia designer but offers learning as an active process. Marked augmentation also allows for robust interactivity between the learner and the media through a two-dimensional QR code. This allows connectivity to multimedia websites, such as the International Space Station at http://www.satflare.com/iss/ which tracks your location and then provides a visual of the real-time location of the Space Shuttle and your live sky chart on both desktop and mobile technologies. This type of interactivity supports a multitude of science, technology, engineering, and mathematics (STEM) instructional environments with minimal coding on the part of the course designers and developers.

Google Glass and similar innovations enter the world of multimedia providing augmented reality through optics. Google uses an optical head mounted display offering an overlay of the user's environment on glass. It is similar to both established military technology in airplanes where logistical coordinates are placed on a glass front panel and the glass teleprompters most politicians use when making a speech. The benefits of this type of device are unwanted light and glare, transparency when not in use and the ease of usability. Google Glass has all functionality of a tablet computer with the addition of optical augmentation. Information appears right before the eyes in the same fashion as marked and markless augmentation which is growing exponentially as Google's satellite continue to add map projections and planar coordinates to its arsenal of information. The accuracy of coordinates is verified through leased street maps from various countries and vendors. Mashups are interfaced through links and geo-tags. Glass has access to Google Earth, Moon and Mars; Google Maps offering multimedia developers street, business listings, aerial and latitudinal views; Google Indoor Maps with Glass allowing navigation through airports, museums, shopping malls, universities and other public spaces. Public universities and facilities can provide floor plans to Google to add to the service. Google's My Places allows users to create maps that can be saved and shared with others. Courses in the geo-sciences, physics, aerospace, and history along with so many interrelated and visual arts curricula can be enhanced constructively with the use of the Google environment and effectively through Glass. It should also be noted that Google has acquired several robotics companies which are capable of augmentation and holographic development as well (Markoff, 2013). The abundance of Google multimedia products is a potential gold mine for innovative developers who can design creative tools which are mobile and augmented through Google Glass.

Figure 2:



Augmented reality using see-through glass is not proprietary to Google. INPRES, a system for Augmented Reality is focusing on information technology in medicine - computer- and sensor-aided surgery. Surgeons performing delicate brain procedures combined the use of infrared cameras with augmented reality glass. INPRES tracked both patient and surgeon during a biopsy operation on a tumor near the skull base and updated the information on the glasses' displays in real-time (Eggers, Sundra, Ghanai, et al., 2005). Surgeons did not have to stop or leave the sterile area to gather additional data, or leave the patient vulnerable and exposed. This augmented reality research has significant implications for patient survival and the future of medicine.

Some experts suggest that multimedia technologies including augmented reality are the beginning of the post-smartphone era. Future users will communicate, receive and work using voice commands, hand gestures and data-collecting wearable devices (Venturebeat.com, 2013). The constraints of Google Glass are its awkward headset and perhaps its obviousness. Everyone in the wearer's environment will know that they are augmented. This can be contrasted with current work at the Defense Advanced Research Projects Agency (DARPA) to create augmented reality contact lenses to perform similar functions (DARPA, 2012). The FDA's approval of a bionic eye for the partially sighted is also emerging (Sifferlin, 2012). The caveat to all the Google innovations is information consistency in an ever-changing world and more importantly, its use of JS API and XML makes it vulnerable to hackers' overlays of the information for hostile competition and other malefic purposes.

Figure 3:

Augmented Reality and QR Codes

The key strategy when planning any form of multimedia is to ensure its interoperability and accessibility to other multimedia tools and innovations. Augmented reality by definition works with a medium in the real world and enhances or expands upon it. AR is not limited to complex back end developments where 2D and 3D must coalesce but also includes QR codes. QR codes can be made for virtually any type of media through several websites such as QRstuff.com or layer.com (.jpeg, .pdf, or .zip), and add rich multimedia content to a static document or banner. QR codes can join commercial partnerships for marketing and promotional purposes. Companies and municipalities use QR codes for marketing, in-store promotions and informational purposes. One such venture in 2012 and 2013 was between Denny's restaurant and Warner Bros. Pictures' movie, "The Hobbit." Through the use of QR codes, Denny's combined robust social networking, its customers and the cult fan base of the movie, to win exclusive gold coins from the latest installment of the trilogy on Denny's social channels. According to Jenson, director of advertising and merchandising at Denny's Corp., Spartanburg, South Carolina, "It was our most successful promotion of all of last year. It was a great interaction between our guests and our brand and The Hobbit property" (Tode, n.d.). Denny's included the QR codes on its placemats at its 1,680 locations nationwide where patrons would use their mobile devices to access various multimedia while waiting for their meals. The QR codes took the patron to exclusive film clips from the movie, a behind-the-scenes look at the Denny's ad for the movie and a Hobbit game. The company reported approximately 120,000 scans per QR code.

In Washington, DC, bus users can check web-enabled smartphones to scan a Bus Time QR Code located on the bus stop pole that displays the route maps and bus schedules. The same usage of QR codes is happening in New York City, Madison, Wisconsin, and Santa Clarity, California, and growing. QR codes are used in transit in British Columbia, Japan and other countries. QR codes provide emergency information, election information and offer much potential for innovative instruction on mobile smartphones and tablets.

In education, QR codes are being explored as desktop QR code tutorials in student projects such as "Around the World in 80 Days using QR codes" providing access to libraries, and providing intensive multimedia to hard copy homework assignments (Anderson, n.d.). QR codes are now being used to link real world objects with all sorts of online data and information (Grantham, 2012).

The multimedia within augmented reality could not be possible without web-enabled mobile technologies like the smartphone, tablets and other multimedia capable and transportable devices. These technologies must be combined with learning methodologies and models such as constructivist learning, guided discovery and adult learning to produce effective knowledge transfer to learners and users. The ongoing theme in multimedia is recognizing that people learn through activity; through actually participating in the engaging processes of learning. It is the integration of multidimensionality that ensures the longevity and success of multimedia innovations.

Mobile Technologies

Mobile technologies, more so than any other entry of new innovations, have transformed the way humans conduct their everyday lives. For many, mobile devices, phones, or tablets are the only tools used to communicate, search the web, and manage their learning and business. Many academic and business entities are diligently considering ways to leverage mobile technology, also called m-learning, to benefit the learning experience and the competitive advantage in business.

The leveraging potential and competitive advantage available through mobile technologies is apparent but companies with annual revenues above 500 million to 5 billion have yet to integrate a mobile strategy into their overall business plans (Hamblen, 2013). According to Eric Lesser, an author and research director at IBM's Institute for Business Value, mobile technologies offer worker efficiencies and global expert knowledge management through social networks and real-time textual and multimedia interactions. Those companies that have incorporated mobile technologies have measureable return on investment while dealing with ongoing issues of security and the challenges of employees using their own devices in the workplace. Innovations in multimedia in tandem with marketing strategies are essential for optimum use of the mobile landscape in business and education.

Figure 3:

Thornton and Houser (2006), Kinjo Gakuin University, Japan, conducted a study to explore ways to use mobile devices with robust multimedia to teach students English. Specifically, the researchers wanted to know to what extent mobile phones were being utilized for educational purposes among university students, and to measure students' reactions to educational materials for foreign language learning developed specifically for mobile phones (Thornton and Houser, 2006). 95% of 15-24 year old Japanese population own web-enabled mobile devices. 95% of the 333 Japanese university students polled used mobile devices for emails with 66% using mobile to email peers about classes and 44% emailed peers about studying. 71% preferred English vocabulary lessons via mobile phones and showed higher learning results than those who received the lessons on paper or via the web. The students described mobile learning as a valuable method of instruction.

Figure 4:

©Unesco.org. 2014. Used with permission.

The United Nation's Educational, Scientific and Cultural Organization (UNESCO) have an annual conference called Mobile Learning Week (MLW). It gives various stakeholders—from governments to NGOs to private companies—a venue to exhibit and share their work. According to MLW, in early 2013, there were approximately six billion mobile phone subscriptions in a world of roughly 7 billion people. Mobile technologies hold great interest for world organizations and governments because of its potential to reach into rural and third-world areas and send information to those people. The graphic interface and multimedia used in mobile technologies can be leveraged to innovate and offer learning equity and literacy through mobile content and technology to previously inaccessible demographics. Learning languages seems to be the prominent multimedia (audio/video) use of mobile technology in global education but other innovations are being explored also. Creating podcasts, coordinating assessments with graphical representations of student understanding, and linking math studies to mobile devices are being tested in many learning environments. A particular emphasis of the United Nations is pushing mobile learning to the forefront of the international education agenda and extending new learning opportunities to women and girls as well as men and boys in resource-poor areas (MLW Symposium Report, 2013). The ease of use and immediate response possible through mobile devices enhance interactions between students and teachers, students to students, and students to information via wireless access to the Internet.

Mobile learning is particularly suited to adult learning models in its agility and informal co-discovery which integrates into the life of learners with families, jobs and time-constraints. Andragogy supports students learning from peers, learning from previous experiences and applying critical thinking to solving problems. In K-12 environments, active learning is enhanced through mobile devices and shifts the focus away from the distraction these devices currently create with younger learners. Secondary schools that had to write new rules to limit smartphone usage in the classroom can now retool those devices to support learning across the curriculum. Mobile devices can be linked to interactive white boards from remote locations allowing learners to communicate and exchange ever more efficiently with their colleagues. Global positioning systems (GPS), a component of all mobile devices, easily integrate in liberal arts learning as well as science, technology, engineering, in addition to the creative arts and mathematics. GPS affords M-learning outside the confines of the classroom or office thereby allowing active engagement and real-time application to occur convenient to the learners' lifestyle.

Project K-Nect curriculum, a specialized program that links math learning with mobile devices, gave students smartphones with Internet access, instant messaging, video and photo capabilities, and calculators. Those students' scores on the state-mandated North Carolina End-of-Course (EOC) tests were 10 percent higher than the state average in the Algebra II and geometry courses and 20 percent higher than the state average in Algebra I (Allen, 2011). The U.S. Department of Education's National Education Technology Plan (NETP) as well as non-profit groups like Project Tomorrow representing universities, philanthropic groups, and technology companies, all support digital multimedia curricula as the way of the future in learning.

When deploying instruction via mobile devices it is important to understand the form of multimedia used and the platform environment in which it will be received. Unlike traditional education with a textbook encompassing the entire content of the course, mobile learning methodologies are just-in-time, on-the-move information access (masternewmedia.org, 2006). Mobile applications require different development configurations and publication settings than LMS or web-based courses but otherwise the same web-authoring tools can be used. Additionally, in the previously mentioned Japanese study, English vocabulary materials were sent to students at timed intervals, in order to promote regular interval study (Thornton & Houser 2001; Houser et al. 2001) whereas LMS and web-based courses are less agile. Learning activities were sent to second and third generation mobile devices, the latter having robust multimedia capabilities to display short, web-based videos and 3D animations and to give visual explanations of English idioms (Thornton et al. 2003). There are now 4D applications with even more multimedia opportunities for expanded learning for students on the move. Several schools are integrating mobile devices with online gaming technologies in the classroom.

It is the norm to see people walking, driving, and shopping engaged with their smartphones and most industries want to leverage this trend in beneficial and competitive ways. However, in a recent study, college students who rely heavily on texting were linked to sleep problems, lower levels of well-being and burnout (Murray, 2013). A more ambitious ongoing study seeks to determine if there is a relationship between a person's chronotype (biological clock), smartphone usage, and productivity (ubicomp.org, 2011). The ease of access to various activities, from social networks like Facebook and LinkedIn to scholarly research, combined with the robust multimedia from audio-video to emoticons, bells and whistles, has an engaging effect on the mobile users. The cognitive productivity of this engagement versus its psychomotor or habitual effects requires further research. Mass usage of mobile technologies is still too young to have substantive evaluative research as a comprehensive learning tool. As a result, academia, governments and businesses continue to associate opportunities with higher levels of risk. The rate of change in mobile multimedia and the proprietary nature of each mobile operating system is also risk factors due to the expense of upgrading or modifying robust, cross-platform multimedia tools once implemented. These decisions cannot be made in a vacuum and new multimedia, such as 4D augmented realities, would be ill-timed if the majority of end users do not have the most recent hardware to support the innovation. Innovations in multimedia using motion sensing input hands-free devices and learning games are being explored as well.

Motion sensing input hands-free devices and touchscreen digital interface innovations & 2D/3D Learning Games

Providing an avenue for learning that accommodates a wide demographic of learners is an ongoing aspiration of both universities and businesses. As developers and instructional designers seek to produce more active learning courses and business solutions, technologies that free the hands from holding the device are becoming more prevalent. The use of sensory infrared technologies can create environments that closely replicate the face-to-face experience. This technology can support the development of robust course learning outcomes where high-engagement, interaction and information-rich communication are integrated into the curriculum (DePriest, 2012).

One of the immerging uses of sensing input technology is virtual reality and telemedicine. In medicine, remote sensors, intelligent systems, telepresence surgery and virtual reality surgical simulations, all serve in the furtherance of efficient healthcare (Satava, 1995). Telemedicine is a broad field that encompasses teleconsultation, electronic patient records, continuing medical education and public health information systems (Garner and Collins, 1997). Clinical analysis, remote consultations and remote delivery of medical monitoring and care into the patients' home are the logical progressions in a global society where the experts and specialists may be anywhere in the world. This is of particular interest to the military in performing combat casualty care but also in the general realms of rehabilitation and even elder care. Unlike in the past when healthcare providers had to be face-to-face with patients, there is now remote technology that can detect non-verbal cues and general physicality. The interoperability of multimedia and medical technology allows vital information to be taken and shared through distributed networks. Recent research provides new insights on how digital technology can overcome previously insurmountable constraints in both training and care in medicine.

Hands-free technologies provide an agile, real-time environment with case-based reasoning that use simulations and face to face chat, video streaming, and even Twitter and Facebook, with others around the world in the privacy of the home. Video hands-free devices can host synchronous or asynchronous conferences or classes that can be viewed by users with Windows or Mac supporting mobile and ubiquitous real- time video mobile devices.

Hands-free devices and related technologies as well as desktop virtualization software use 3D imagining and display multimedia. This allows for 3D virtual scene perception, 3D shape analysis, and 3D reconstructions of cells, objects, and organs (Yang and Liu, p. 1, 2013). The devices have speech-recognition which filters out background noises from the user's voice using an engineered audio cone around the user's body even if they are moving. Facial recognition through biometrics affords the users security of information and copyrighted materials, collaborative curriculum and training, and management of business and government environments.

The challenge for developers and designers when building multimedia innovations in this medium is the various platforms used for gaming. Devices connected to televisions are rarely compatible with one another requiring the institution building the multimedia to either provide each user with the accepted platform device or develop several versions of the same module. Apple and Microsoft in collaboration with K-12 academic institutions have programs which distribute the platform to all the students through leasing or purchasing. Gaming platforms like X-Box, PlayStation and Wii offer software versions particular to the user's computing hardware in order to synch the devices into one computing environment. Playstation, among others, allows users to view multimedia and have interactivity using any synched devices from virtually any location.

Figure 5:

Games have emerged as academic inquiry in professional conferences, peer-reviewed articles and books, as well as among faculty and programs (Alexander, 2008). Object-oriented platforms, define learning objects as "a collection of content items, practice items, and assessment items that are combined based on a single learning objective (Wikipedia). Research on digital learning objects confirms that components of teaching and learning are present in most electronic games. The learning environment in gaming allows modularity or content reusability. The intriguing combination of robust multimedia, start points and destinations, rules and required progressions, creates a constructivist learning environment for knowledge transfer to occur. Gaming can be single or multiplayer building upon the users critical-thinking and decision-making as well as teaming skills. It would be difficult to find an area of learning that would not be enhanced by the use of learning games including such complex fields as the military and surgical medicine.

The largest research area where learning games are being explored currently is the military. The COMET project is focused on rehabilitation, telemedicine, training and education, neurocognitive and psychological treatment (DePriest and Barilovits, 2011). Students can attend a laboratory through Xbox LIVE where they can have real time virtual (or real) laboratory experiments supervised remotely by the facilitator of the course. The motion tracking abilities of Xbox Kinect have valuable applications for physical therapy and home rehabilitation exercises. Doctors and patients connect through Xbox Live with rehab courses prescribed, graded, and assessed (DePriest and Barilovits, 2011).

Figure 6:

Learning games allow the user to create their own sub-narrative in the storyline which can be interpreted as constructing their own learning. Games with well-developed multimedia allow the user to modify or choose various twists and turns when engaging in the experience. Research suggests that games and simulations, where the learner's perceived realism is heightened, increased the relevance for the learner. Learning games provide cross-dimensional stimulation through the game mechanics, interactivity, imaging tools and visualization (Felicia, 2012). Many games have an auxiliary component involving blogs, wikis and online teams where collaborative learning takes place.

The Situated Learning method has its origins in the constructivist theories with its underlying premise that learning is an active process. Situated learning distinguishes itself from constructivism by allowing an individual to learn by socialization, visualization, and imitation (DePriest, 2012). Situated learning moves from the role of passive observer to a fully functioning peripheral participant (Herrington and Oliver, 2009) in the learning. Games as an integrated tool-set within a robust curriculum are effective due to the immersive, interactive and goal-oriented medium as well as the inherent requirement of reflection. The learner alternates between immersion and reflection in support of constructivist/situated learning environments.

At first glance, there are many potential benefits to blending games into the learning environment. However, learning games versus recreational ones are slow to reach mainstream academia or business. The most disconcerting reasons for this delay is the time and expense involved to develop and design games specific to the desired learning intention. Secondly, all learning games are not developed alike requiring solid pedagogical knowledge by all the stakeholders on different modes and uses of games in learning contexts. According to research conducted by Freitas on game-based learning (2012), the ranges of diverse games that are being used currently in learning and training practice are as follows:

> 1. Games as metaphors - Games are being used to support learning communities through considering games as metaphors – e.g. metaphors of the real world, or of fantasy worlds for experimentation and exploration. This approach works well with younger learners, and has been used most widely in schools.
>
> 2. Games or simulations as microworlds - Using games or simulations as microworlds where open-ended experimentation can take place is becoming more commonplace in educational contexts, as techniques more often associated with training for professional life are adapted. This technique, like role play and the use of narratives, may prepare

> individuals for exploring a range of different skills and activities within a cohesive and safe environment that may or may not be transferred to real life contexts.
>
> 3. Games as tools (for therapy and skills development) - Games are being used as tools to support a range of activities such as therapy and to support skills development (e.g. literacy and numeracy). Games as tools for therapy include games as pain relievers (Pelletier, 2005), for supporting corrective or constructive therapy and for medical training (Begg et al. 2006). To date this approach has been used for supporting specific medical or mental health conditions, for example for burns victims or for autistic children. The potential of this approach is becoming more apparent, and a large investment is being made in particular in the United States to support wider applications. (deFrietas, 2012, p.3).

In general, the key to success using learning game lies in forging a relationship that allows students to be creative, idealistic, and passionate, while still meeting educational and multimedia goals for quality and performance (DePriest and Barilovits, 2011). The challenge is in developing a user-oriented and performance-oriented viewpoint when defining the interaction between people and products. This takes into consideration the users' emotions, values and prior experience, the right functions of the product required for users to perform their tasks efficiently and to accomplish their goals, and the learning task to ensure cognitive-product interaction or guaranteeing appropriate resources for relevant information processing (Kiili, deFreitas, Arnab & Lainema, 2012). Initially, the inclusion of games into a learning environment is a top-down strategic initiative requiring a clear understanding of the investment opportunities and risks. The investment remains quite expensive, about $1,000 per console, which is price prohibitive for large scale or global learning initiatives. Another example of risk is developing multimedia for gaming consoles whose manufacturers seldom include backward-compatibility. There are strong opportunities for hands-free technology and learning games in medicine and the military. Learning games, like any other parts of curriculum and multimedia design, must be championed in the strategic plan and budget of the institution.

Future Trends

A significant innovation in the integration of various tools and multimedia that will have significant implications in the future is on-the-go storage. Practical experience gleaned from using and thinking digitally in global environments has rewritten the way information is stored. Physicality in order to learn and communicate is no longer efficient in business or education. There is a large demographic of adult learners who are managing jobs and families, and who do not have lifestyles befitting the traditional classroom. Most devices today are equipped with mechanisms to save information to CDs, USB drives and the cloud with terabytes of storage. With the onset of cloud storage, assignments and research web pages can be downloaded using wireless technologies from any location. Multimedia developers can create remote information that workers and learners can gather, manipulate and then resubmit for seamless collaboration and assessment regardless of location.

Another future trend in multimedia is augmented optical learning. Loosely imagine augmented optics through the Star Trek™ series where people were transported to another location through beams of light. Innovative multimedia using light or optics allows the image, not the organic form, to beam to another location and even animate to appear alive. This is already happening through image recognition technology that integrates augmented reality. It seamlessly animates any image making it appear sentient including live news (Mills and Roukaerts, 2012). Overlain live news is an innovation for the relatively new specialization called multimedia journalism where print or text-based stories are augmented by a video or other multimedia enhancement (Lee, 2008). Aurasma©, a company that makes augmented reality for mobile phones, calls these animated images by the name “auras.”

Systems such as ASTOR, an autostereoscopic optical see-through spatial augmented reality, provide real-time 3D visual feedback without the need for user-worn equipment, combining interactive computer graphics with real objects in a physical environment (Olwal, Gustafsson and Lindfors, 2008). Visualize running a red/stop traffic light (unintentionally, of course). An aura of a police officer appears motioning you to pullover into an autoport using a transparent holographic optical element overlaid onto glass. Within that autoport, the augmented reality aura or officer image takes you through the ticketing process online via the wireless functionality within the port. The officer is a product of AR developers' precise tracking of real-world coordinates, move-matching, and then blending the visualization with the actual surroundings. Your license, registration, name and address information are provided through a global database. You sign the ticket electronically and it is sent directly to your email. Should you try to ignore the augmented officer and continue to drive, multimedia then defaults to computer science; the industry standard GPS or remote vehicle disabling system will track and detain your vehicle.

Many research universities, governments and businesses continue to evolve the way we interact with, and augment, our environments. Augmented reality machines now offer a seamless integration between computer-generated imagery and live, real-time video footage. The future holds a commonplace augmented world of man and machine. According to Marco Tempest, a magician and illusionist who combines augmented reality in his work, "We think on narrative structures and [through multimedia] create" our desired reality (Tempest, 2012).

The future of glass cannot be overemphasized. In education, classes will be beamed to the learners' location at their convenience with interactive optical images of their teachers. Students combined with video and sensing input technologies, will be able to ask the teacher to repeat, pause, post questions or comments in real-time which will seamlessly transmit to the facilitator-on-duty at the school. This is already being done in some online education environments that provide massive open online courses (MOOCs) but without the optical representation and real-time interaction of the instructor. Combined with fully layered, tracked and matched planar global environments, the students' augmented glass device with sensing input and multimedia such as virtual whiteboards, will allow active engagement with the course and the teacher.

Animation, a key aspect of augmented reality multimedia, is distinguished from the clipart and cartoon animations of the past through immersive technologies. Animation today is designed to be an allusive part of the vital reality. The majority of animations today, such as Second Life®, the continuous motion and shape changes in Japanese anime or in modern Pixar© and Disney© movies, are designed similarly to augmented environments but without the planar measurements. In character animation, sensors are placed on the humans shadowing the animated roles. Humans perform the activities that will become, along with the design of the artists, the illusion of thought, emotion and personality. According to Dreamworks™ (n.d.), the animation production process is a delicate balance between creativity and technology taking three to five years per movie. There are very few advertisements, movies or television shows today that do not use some form of animation-augmentation with the audience virtually oblivious to the manipulations. The sky is the limit for this multimedia innovation because it is a transparent marriage of science and imagination. It relies on the assumptions of the optical brain to process what it sees as real, sentient or non-fiction.

Last but certainly not least is humanoid robotics. The Defense Advanced Research Projects Agency (DARPA) along with private interests are actively building and perfecting such robots as Cheetah Robot and Big Dog (Boston Dynamics/Google/DARPA), Asimo (Honda/DARPA) and Atlas (DARPA) but these are only a few examples of humanoid robot development. Humanoid robots are hardware designed with bionic sensors, advanced intelligence and analytics providing superhuman efficiency. Robots have been a growing phenomenon since the industrial age and there are commercially distributed mobile and off-road robotics as well as household robotics for mass distribution. The focus towards the future is to develop more and more enhanced human characteristics in robots such as assisting in recovery during nuclear disasters, natural disasters and war. Humanoid robots can independently walk, run, and maintain agile balance. They have delicate infrared heat sensors and sonar to detect life or human presence over wide ranges of terrain. Humanoid robots have sensitive touch and fingering to find, open and carry, and are being designed with neural networks and cognitive processes to communicate similar to human interactions. The humanoid robot development involves complex multimedia algorithms, genetic and decision support systems capabilities such as neural linguistic processing, data and text mining and more discrete forms of artificial intelligence.

Conclusion

For every new multimedia innovation there is a relative measure of influence had upon our lives. These influences affect the way we interact with our environment, the way we learn and the tools we use to relate to each other. In the same way as the behavioral metamorphosis with mobile technology is seen among humans, the future holds new worlds rich with multimedia potential.

The old adage, “a picture is worth a thousand words” refers to visualization allowing large amounts of information to be received quicker to our neural pathways through multimedia. Users all over the world prefer graphics over text-based lists especially in communicating concepts of interest (Raney, Jackson, Edwards, et. al, 2002). Global interactions among governments, businesses and academia rely heavily on world recognized graphics from signs depicting biohazard, caution, and hand gestures, as well as universally recognized design, algorithm and coding conventions. Global medicine and fuzzy logic surveys like the Likert Scale and its statistical equivalent tools use graphics in what-if analysis and correlations to measure reaction and opinion levels. Users recall information better when there are robust graphical or multimedia components. This does not promote the overuse of animations or any such tool but it does give developers insight into the relationship multimedia has with user recall and recognition. It suggests the possibility that multimedia may increase the likelihood that a user would return to the website, the class, or better engage in a business venture. Multimedia lends credence to continued engagement and ongoing interaction when used in tandem with meaningful content.

Learning management systems are evolving to include mobile access capabilities while continuing in the efforts to duplicate the sense-of-presence aspects of the face-to-face classroom. The challenges of LMS are their bulkiness and the difficulty for learners to navigate within them in a timely manner. LMS that require more than two clicks to get to a discussion forum or to submit an assignment create frustration for the learner. LMS housed within servers that frequently crash also diminishes the on-the-go factor so many adult learners require in their lives. The major benefit of an LMS is having all activities centralized in one place which makes data gathering and data capture manageable. Documentation, collaboration and automated assessment tools within the LMS environment provide solid measurement tools for online universities and certification providers. An LMS without appropriate multimedia can be a static and claustrophobic environment causing learners to sign in, post quickly without sufficient reflection, depth or breadth, complete tasks, and then swiftly sign out. This behavior is counterproductive to most types of active learning where students actively engage in the learning process and immersive multimedia. It may also contribute to the retention problems that plague the online academic environment.

Augmented reality, a transparent multimedia tool, enhances the user's real-world experience through heightened sensory and immersive technologies. Augmentation combines existing and future technologies with science and imagination (when applied to animation). There is virtually no limit to its potential in academia, government and business environments.

Learning games have wide capabilities yet to be fully leveraged using infrared sensors, surround sound audio and hands-free devices in 2D, 3D and 4D environments. These games and devices have entered several industries from medicine to engineering, and also military learning. Learning games are tools with great potential for users with disabilities or with limited mobility and have usage for learners of all ages.

Mobile technologies with interactive, multimedia interface have infiltrated every continent and demographic all over the world. Mobile devices are the main focus of many global efforts to modernize and afford opportunities in third-world countries and other remote locations due to their size, affordability and ease of set-up via cellular towers, Wi-Fi or satellite technologies. In the Western world, mobile devices are the 11th digit in the user's hand or appendages to the ear with hands-free Bluetooth engaged, and serve as mental hard drives for remembering appointments, phone numbers and directions.

Multimedia transcends global barriers and enhances communications in academic, government and business environments. Well-designed multimedia innovations take into account the wide range of backgrounds among learners. Appropriate design and development of multimedia tools allows for different levels and types of previous learner experience, particularly with computers. Active involvement in learning through multimedia allows for self-direction and guided discovery; where learners can immediately try out new ideas in the workplace, reinforce facts and theories in the classroom, or iterate previously known information. Combined with the appropriate methodology or model, multimedia becomes a dynamic platform for the exchange of knowledge and ideas between people previously unreachable due to global limitation, socio-economics or the demands of a busy lifestyle. It is certain that the emergence of multimedia and its future innovations are here to stay.

KEY TERMS AND DEFINITIONS

2D/3D learning games – digital video games designed for teaching

ADDIE – a framework for instructional designers to use, Analysis, Design, Development, Implementation, and Evaluation

Adult learning andragogy – teaching methods and curriculum catered towards adults.

Affective domains – background information, usually used in making assumptions within the learning space

AICC – a standard in internet-based learning that regulates the creation, publication and use of internet courses. Developed from an aviation organization that pioneered eLearning

Apple video codec – a proprietary video coded developed by Apple, Inc. Synonymous with QuickTime video codec.

Articulate – an eLearning course development software developed by Articulate Global.

Augmented/mediated – altered or changed in some way

Autostereoscopic algorithms – an algorithm for displaying 3D images without the use of external head gear or physical augmentation.

Biometrics – the use of human physical characteristics like fingerprints or retinal scans as a method of identification.

Broadband – a telecommunications standard through which the data/signal is transported either through an optical fiber or wirelessly.

Cable – a telecommunications standard through which the data/signal is transported exclusively through wire. Less commonly referred to as "baseband" in contrast to broadband

Compression – the act of systematically reducing the size or frequency peaks of a specific file in order to more easily transport it in a specific file medium.

Cross-platform – an adjective describing a program that can be run on multiple different systems (e.g. Mac OS and Windows, Android and iOS, Xbox and PlayStation)

Decentralized network topologies – the arrangement of a network in which every node acts independently. Commonly referred to as a "peer-to-peer" network, a system such as this removes the distinction between server and client, allowing any node within the system to act as either a server (providing the content) or a client (receiving).

Delivery systems – a network set-up that allows for the delivery of data from a server to a client

Demographics – a description of a certain population based on a certain defining characteristic, e.g. platform preference, living arrangements.

Dithering – broadly speaking, the act of mixing and merging different pieces of data to find and eliminate error. In photo/video editing, dithering refers to the merging of colors in order to produce more "true" or accurate colors.

Global positioning systems – a space-based system that can use both satellite imagery and somewhat precise tracking to provide someone's local.

GUI – graphical user interface, the visual and "user-friendly" end of a device, usually featuring a taskbar or ribbon of some sort, along with a way to access the various commands of the device.

HACP - HTTP AICC CMI Protocol, an LMC protocol.

Holographic algorithms – a method of displaying 2D images in a 3D space, often through visual chicanery

JS API – an application programming interface designed for JavaScript.

Lectora – an eLearning course development software developed by Trivantis

Methodologies – the way in which one goes about designing or teaching something.

MOOCs – "massive open online courses," a rising method of open source education that allows students to get free education, but often charges fees for certification.

Motion sensing – the act of tracking minor disturbances in the immediate vicinity of the object in order to track location.

Move-matching/structure-and-motion – the act of inserting computer generated objects into live film footage. Technique is often used in film and in augmented reality.

Multimedia knowledge transfer – the use of multimedia techniques like videos as a means of transferring knowledge from one part of an organization to another

Networking – a system for sharing information and services among both individuals and other organizations. Most specifically, it's the creation/design of said systems.

Packet-switching – in networking, grouping all data pieces into packets despite their relative size or contents.

Pedagogy – the science of teaching, the term originally meant "the science of teaching children" (read: "peda" being the root meaning child) but has since expanded to all facets of teaching. Originally used in contrast to the word "andragogy," a term meaning "the science of teaching adults"

Petabytes – a term meaning 10^{15} bytes of information. A petabyte is 1000 terabytes, which is itself 1000 gigabytes.

Rapid instructional design – a rational, step-by-step teaching method that ensures that the students are constantly challenged with new, rapidly appearing material.

Rapid Instructional Design Model – a teaching model designed to incorporated accelerated learning techniques that strives to design the learning environment with more practice, feedback, and experience rather than presentations. It is based on four phases: preparation, presentation, practice, and performance.

Rapid Prototype Design – a design process wherein a prototype is developed for testing, review and revision. The process is designed to reduce the time spent in the concept/development phrase.

SCORM – see AICC

Sensory Infrared Technology – the hardware and software behind passive infrared sensors, which track IR light within its view.

Simulation – an artificial recreation of a specific event or scenario. Used in business to test products or try new forms of engagement/action

STEM – an acronym for "science, technology, engineering and math," essentially the "hard sciences."

Streaming – the passing of media through the internet at a constant rate so the end user can watch it either concurrently, or at a steady pace. Notable examples of streaming media include YouTube, Netflix and Spotify.

Subject matter inputs – someone who, rather than being a subject matter expert, simply contributes to the dialogue or discussion.

Terabytes – 10^{12} bytes of information. For more, see the Petabyte definition.

Virtualization – the act of creating a virtual (read: not real) version of something for either demonstrative or testing purposes. This act can apply to operating systems (which can be run on a virtual drive to maximize hard drive space), programs (which can be "sandboxed" to prevent strain on vital components of the system) and storage devices (to reduce the impact on the system). Notable examples of virtualization include mobile and console emulation (for replicating the experiences found on phones and game consoles) and database virtualization (for presenting data as independent of other structures.)

References

Alexander, B. 2008. Games for Higher Education: 2008. Retrieved from http://www.educause.edu/ero/article/games-higher-education-2008

Allen, R. (2011). Can Mobile Devices Transform Education. Retrieved from http://www.ascd.org/publications/newsletters/education-update/feb11/vol53/num02/Can-Mobile-Devices-Transform-Education%C2%A2.aspx

Amiga. Retrieved from http://en.wikipedia.org/wiki/Amiga

Anderson, S.W. (n.d.). QR Codes in Education. Retrieved from http://www.livebinders.com/play/play/51894

Atlas robot video. Retrieved from https://www.youtube.com/watch?v=zkBnFPBV3f0&inf_contact_key=39b5e1aa939b28e807f1a3efc837774593fe5b3f42b25a807aad1b7d6b380311

Berruti, L., Davoli, F., Zappatore, S, Massei, G. and Scarpeillo, A. (2008). Remote Laboratory Experiments in a Virtual Immersive Learning Environment. Retrieved from http://www.hindawi.com/journals/am/2008/426981

Big dog robot video. Retrieved from https://www.youtube.com/watch?v=cNZPRsrwumQ&inf_contact_key=7ba63adeab8b8c4a22a838f122178aa3beafdd071534f29576ea1b7f194bc4cf

Brief timeline of the Internet (2010). Retrieved from http://www.webopedia.com/quick_ref/timeline.asp

Bush, V. (March, 1996). As we may think. Interactions 3, 2, pp. 35-46. DOI=10.1145/227181.227186 http://doi.acm.org/10.1145/227181.227186. Retrieved from https://dl.acm.org.

Carroll, J.M. (1996). Minimalism beyond the Nurnberg Funnel. Retrieved from http://www.instructionaldesign.org/theories/minimalism.html.

Cheetah robot video. Retrieved from https://www.youtube.com/watch?v=chPanW0QWhA&inf_contact_key=b41152b58e23d67579da25a26e3c7a27cd17e9ffaa3110154f64f8eb5f4a6b2e

Clockwise: Inferring Chronotype and Daily Patterns from Smartphone Use. Retrieved from http://www.ubicomp.org/ubicomp2013/dc/abdullah-jr-ds-crc.pdf

Cohen, D. I. and Rosenzweig, R. (n.d.) Digital History: A Guide to gathering, preserving and presenting the past on the web. Retrieved from http://chnm.gmu.edu/digitalhistory/starting/4.php

Craik, F.I.M., Routh, D.A. and Broadbent, D.C. (1983). On the Transfer of Information from Temporary to Permanent Memory [and Discussion]. Pp. 341-359. Retrieved from http://rstb.royalsocietypublishing.org/content/302/1110/341#related-urls

DARPA Researchers Design Eye-Enhancing Virtual Reality Contact Lenses (2012). Retrieved from http://www.darpa.mil/NewsEvents/Releases/2012/01/31.aspx

DePriest, D.L. (2011) Exploring Learning Games. SIDLIT Symposium, Olathe, Kansas.

DePriest, D.L. (2012). Kinecting Virtual Realities. https://www.youtube.com/watch?v=oj_ufx5jAiI. Expo E-Learning, Madrid, Spain. Sponsored by Clay Corporate, Madrid, Spain..

DePriest, D.L. and Barilovits, K. (2011). Xbox: A New Way to Kinect Virtual Realities. http://etec.hawaii.edu/proceedings/2011/DePriest.pdf. *TCC Online Conference Proceedings*.

DePriest, D.L. and Giannoni, D. (2013, April). Massive Open Online Course (MOOC). Paper presented at TCC Online Conference.

DePriest, D.L. Presenter. (2012, August). How Augmented Reality is Launching Worlds within Our World, SIDLIT Symposium, Olathe, Kansas.

Dreamworks. (n.d.) Retrieved from http://www.dreamworksanimation.com/insidedwa/productionprocess

Eggers, G., Sundra, G., Ghanai, S., Salb, T., and Dillman, R., Marmulla, R., and Hassfeld, S. (2005). Augmented-reality-guided biopsy of a tumor near the skull base. Retrieved from http://proceedings.spiedigitallibrary.org/proceeding.aspx?articleid=860558

Flacy, M. (2013). 30% of Americans do not have broadband access at home. Retrieved from http://www.digitaltrends.com/computing/30-percent-of-americans-no-broadband/#!zqRor

Frillings, Karrin. (2013). Stay in the Know: ADDIE vs. SAM. Retrieved from http://www.acceleratedbr.com/blog/stay-in-the-know-addie-vs-sam/#sthash.sjfiYYmR.dpuf

Garner, P., Collins, M., Webster, S.M. and Rpse. D.A.D. (1997). The application of telepresence in medicine. Retrieved from https://www.researchgate.net/publication/226428618_The_application_of_telepresence_in_medicine?ev=srch_pub

Ghanbari, M., Wu, F., Zhang, C., Alregib, G. and A. Vasilakos. (2008). Multimedia Immersive Technologies and Networking. Editorial. Retrieved from www.downloads.hindawi.com/journals/specialissues/594784.pdf

Good constructivist – guided discovery debate. Retrieved from http://cdn6.museumplanner.org/wp-content/uploads/2011/11/Constructivism_(learning_theory)

Grantham, N. (2012). 5 Real Ways To Use QR Codes In Education. Retrieved from http://www.fractuslearning.com/2012/02/20/qr-codes-in-education/#sthash.RUwOYxyJ.dpuf

Gupta, P (2012). Game Based Learning. Proceedings of the 6th European Conference on Game Based Learning. October 4-5, 2012. Edited by Dr. Patrick Felicia. Retrieved from http://academic-conferences.org/ecgbl/ecgbl2012/ecgbl12-home.htm

Hamblen, Matt (2014.) Only half of large companies have strong mobile strategies. Retrieved from http://www.computerworld.com/s/article/9244256/Only_half_of_large_companies_have_strong_mobile_strategies

Handheld Technology Entering the Classroom. (2011). Retrieved from http://www.whyscience.com/2011/11/handheld-technology-entering-the-classroom/

Herrington, J., & Oliver, R. (2009). Critical characteristics of situated learning: Implications for the instructional design of multimedia. Retrieved from http://www.konstruktivismus.uni-koeln.de/didaktik/situierteslernen/herrington.pdf

How Robots Will Change the World video. BBC documentary. Retrieved from https://www.youtube.com/watch?v=8zP7yP8hdLE

Hung, D. (2002). Situated cognition and problem-based learning: implications for learning and instruction with technology. Journal of Interactive Learning Research, 13(4), 393-415.

International Space Station. http://www.satflare.com/iss/

Johnson, L., Levine, A., & Smith, R. (2011). The Horizon Report (2011 ed.). Austin, TX: The New Media Consortium. Retrieved from https://net.educause.edu/ir/library/pdf/HR2011.pdf

Kiili, K., deFreitas, S., Arnab, S. and Lainema, T. (2012). The Design Principles for Flow Experience in Educational Games. Retrieved from http://sgi.cueltd.net/publications/papers/flow_vs-games-kiili-30_5_2012%20Tlai.pdf.

Kinect-Driven Interface Turns 3D Shapes and Movements Into Reality. Retrieved from http://mashable.com/2013/11/12/mit-inform-kinect/

Knight, W. (2005). Augmented Reality Machine Works in Real-Time. Retrieved from http://www.newscientist.com/article/dn6965-augmentedreality-machine-works-in-real-time.html#.UqnpWfRDvLk

Learning Object. Retrieved from http://en.wikipedia.org/wiki/Learning_object

Knowles, M. S. (1984) Andragogy in Action. Applying modern principles of adult education. San Francisco: Jossey Bass

Learning on the Move: MLearning is Next. Retrieved from http://www.masternewmedia.org/news/2006/01/17/learning_on_the_move_mlearning.htm

Learning with Mobile Technologies. Retrieved from http://www.unesco.org/new/en/education/resources/online-materials/single-view/news/learning_with_mobile_technologies/#.UqjI6PRDvLk

Lee, L. (2008). Multimedia Journalism: The Age of New Technology and New Opportunities. Retrieved from http://www.sensibletalk.com/journals/lorraineklee/200808/57/

Markoff, J. (2013). Google adds to its menagerie of robots. Retrieved from http://www.nytimes.com/2013/12/14/technology/google-adds-to-its-menagerie-of-robots.html?inf_contact_key=58c02abd5d856aa783bb47a043d310049731c11cd8aa1923eac3dabded569a7f&_r=0

Mayer, R.E. (2004). Should there be a three-Strikes Rule Against Pure Discovery Learning? American Psychologist, 59(1). Retrieved from http://projects.ict.usc.edu/itw/vtt/MayerThreeStrikesAP04.pdf

Morrison, G.R., Rossm S.M., Kalman, H.K. and Kemp, J.E. (2011). Designing effective instruction. 6th edition. New York: John Wiley & Sons.

Multimedia History (n.d.) Retrieved from http://bc065.k12.sd.us/Multimedia/Introduction%20to%20Multimedia/History%20of%20Multimedia.pdf

Murray, R. (2013). Study links heavy text messaging with sleep problems among college students. Retrieved from http://www.nydailynews.com/life-style/health/texting-linked-sleep-problems-study-article-1.1472926#ixzz2nHqJodqZ

Norman, K. (1991). The psychology of menu selection. Retrieved from http://www.instructionaldesign.org/domains/computers.html.

Olwal, A., Gustafsson, J., and Lindfors, C. (2008). Spatial augmented reality on industrial machines. Retrieved from http://proceedings.spiedigitallibrary.org/proceeding.aspx?articleid=810826

Oxford University Press (2011). One in six IT projects ends up ‘out of control’. Retrieved from http://www.ox.ac.uk/media/news_stories/2011/110822_1.html

Oxford University Press. ELT Multimedia Support retrieved from https://elt.oup.com/multimediasupport?cc=us&selLanguage=en

Pense, H.E. (2011). Smartphones, Smart Objects, and Augmented Reality, pp. 136-145. Retrieved from http://www.tandfonline.com/doi/abs/10.1080/02763877.2011.528281#.UqjX__RDvLk

Piskurich, G.M. 2006. Rapid instructional design: Learning ID Fast and Right. 2nd ed. Pfeiffer – New York: A Wiley Imprint.

Queensland Occupational Therapy Fieldwork Collaborative. (2007). Adult Learning and Six Principles of Andragogy. Retrieved from http://www.qotfc.edu.au/resource/?page=65375

Rainer, G (2012) Classroom versus in-Situ Simulation. Proceedings of the 6th European Conference on Game Based Learning. October 4-5, 2012. Edited by Dr. Patrick Felicia. Retrieved from http://academic-conferences.org/ecgbl/ecgbl2012/ecgbl12-home.htm.

Raney, A. A., Jackson, J.R., Edwards, D.B., and Schaffler, K.L., Arrington, J.B., and Price, M.R. (2002). An Experimental Study: The Relationship Between Multimedia Features and Information Retrieval. Retrieved from http://quod.lib.umich.edu/j/jep/3336451.0007.304?rgn=main;view=fulltext

Rapid Instructional Design. Retrieved from http://www.nwlink.com/~donclark/hrd/learning/id/RID.html

Satava, R.M. (1995). Virtual reality and telepresence for military medicine. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/7554840

Sifferlin, Alexandra (2012). FDA Approves First Bionic Eye. Retrieved from http://www.cnn.com/2013/02/19/health/fda-bionic-eye/

Simon, G., Fitzbibbon, A.W. and Zimmerman, A. (2011). Robotics Research Group, Department of Engineering Science, University of Oxford, United Kingdom. Retrieved from www.robots.ox.ac.uk/~vgg/publications/papers/simon00.ps.gz (pdf).

Strange, A. (2013). Kinect-Driven Interface Turns 3D Shapes and Movements Into Reality. Retrieved from http://mashable.com/2013/11/12/mit-inform-kinect/

Symons, Tim (2011). AICC-or-SCORM-which-is-best-for-packaging-e-learning-content. Retrieved from http://www.acceleratedbr.com/blog/aicc-or-scorm-which-is-best-for-packaging-e-learning-content/

Teachers College Record. Irving Lorge. Retrieved from https://www.tcrecord.org/AuthorDisplay.asp?aid=8800

Ted Talks (2012). Marco Tempest: A magical tale (with augmented reality). Retrieved from http://www.ted.com/talks/marco_tempest_a_magical_tale_with_augmented_reality.html

Ted Talks (2012). Matt Mills: Image recognition that triggers augmented reality. Retrieved from http://www.ted.com/talks/matt_mills_image_recognition_that_triggers_augmented_reality.html

The history and development of multimedia: A story of invention, ingenuity and vision. Retrieved from http://people.ucalgary.ca/~edtech/688/hist.htm#ninties

Tode, Chantel (n.d.) Denny's boosts QR code, augmented reality strategy with social campaign. Retrieved from http://www.mobilecommercedaily.com/denny%E2%80%99s-fires-up-mobile-strategy-with-qr-codes-plus-augmented-reality

Vehicle Disabling Systems (n.d.). Retrieved from http://www.fmcsa.dot.gov/facts-research/systems-technology/product-guides/vehicle-disabling.htm

Wearables by design: Welcome to the post-smartphone era (2013). Retrieved from http://venturebeat.com/events/mobilebeat2013/

Woolf, B. and Hall, W. (1995). Multimedia Pedagogues: Interactive Systems for Teaching and Learning," IEEE Computer, Special Issue on Multimedia, Vol. 28 (5): 74-80.

Yang Y, Liu Q, Ji R, Gao Y (2013) Remote Dynamic Three-Dimensional Scene Reconstruction. Retrieved from http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0055586

Zemke, R. and Zemke, S. (1995). Adult learning what do we know for sure? Retrieved from http://www.ebacs.net/pdf/building/10.pdf

Index

Page - 22

Page - 35

Affective domain:

- Also known as: Bloom’s Taxonomy of Learning Domains
- Similar to: growth in feelings or emotional areas (Attitude or self)
- Associated in the manuscript with: the types of learning
- Notable appearances of this term can be found on:

Page -1

AICC:

- Also known as: Aviation Industry CBT [Computer-Based Training] Committee
- Similar to: SCORM, Tin Can API, learning management systems (LMS)
- Associated in the manuscript with: a standard in internet-based learning that regulates the creation, publication and use of internet courses. Developed from an aviation organization that pioneered eLearning.
- Notable appearances of this term can be found on:

Page - 13

Apple video codec:

- Also known as: QuickTime video codec
- Similar to: A codec is a device or computer program capable of encoding or decoding a digital data stream or signal.
- Associated in the manuscript with: a proprietary video coded developed by Apple, Inc.
- Notable appearances of this term can be found on:

Page -

Articulate:

- Also known as: a Web-authoring tool
- Similar to: Lectora, Toolbook, Dreamweaver
- Associated in the manuscript with: an eLearning course development software developed by Articulate Global.
- Notable appearances of this term can be found on:

  Page - 13

Augmented/mediated:

- Also known as: a technology that superimposes a computer-generated image on a user's view of the real world, thus providing a composite view.
- Similar to: Google Glasses, simulations
- Associated in the manuscript with: Augmented Reality and QR Codes
- Notable appearances of this term can be found on:

  Page - 3

  Pages – 14 - 18

  Pages – 20 - 33

Biometrics:

- Also known as: the use of human physical characteristics like fingerprints or retinal scans as a method of identification.
- Similar to: quantifiable data (or metrics) related to human characteristics and traits
- Associated in the manuscript with: 2D/3D Learning Games
- Notable appearances of this term can be found on:

  Page - 26

Broadband:

- Also known as: a telecommunications standard through which the data/signal is transported either through an optical fiber or wirelessly.
- Similar to: cable
- Associated in the manuscript with: Background: Modern Media
- Notable appearances of this term can be found on:

  Page - 8

  Page - 9

Compression:

- Also known as: the act of systematically reducing the size or frequency peaks of a specific file in order to more easily transport it in a specific file medium.
- Similar to:
- Associated in the manuscript with: Background: Modern Media
- Notable appearances of this term can be found on:

  Page - 6

  Page - 7

Cross-platform:

- Also known as: an adjective describing a program that can be run on multiple different systems (e.g. Mac OS and Windows, Android and iOS, Xbox and PlayStation)
- Similar to: software application programs
- Associated in the manuscript with: Learning Management Systems (LMS)
- Notable appearances of this term can be found on:

  Page - 11

Page – 13

Decentralized network topologies:

- Also known as: the arrangement of a network in which every node acts independently. Commonly referred to as a "peer-to-peer" network, a system such as this removes the distinction between server and client, allowing any node within the system to act as either a server (providing the content) or a client (receiving).
- Similar to: Peer-to-peer networks
- Associated in the manuscript with: Background – Modern Multimedia
- Notable appearances of this term can be found on:

  Page - 5

Delivery Systems:

- Also known as: a network set-up that allows for the delivery of data from a server to a client
- Similar to: decentralized network topologies
- Associated in the manuscript with: abstract
- Notable appearances of this term can be found on:

  Page - 2

Demographics:

- Also known as: a description of a certain population based on a certain defining characteristic, e.g. platform preference, living arrangements.
- Similar to: personal characteristics
- Associated in the manuscript with: Mobile technologies
- Notable appearances of this term can be found on:

Page - 2

Page - 10

Page - 22

Dithering:

- Also known as: broadly speaking, the act of mixing and merging different pieces of data to find and eliminate error. In photo/video editing, dithering refers to the merging of colors in order to produce more “true” or accurate colors.
- Similar to: multimedia
- Associated in the manuscript with: Background: Modern Multimedia
- Notable appearances of this term can be found on:

Page - 7

Global positioning systems (GPS):

- Also known as: a space-based system that can use both satellite imagery and somewhat precise tracking to provide someone’s local
- Similar to: satellite technology, cellular technology
- Associated in the manuscript with:
- Notable appearances of this term can be found on:

Page 22