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ORIGINAL PAPER

Connected and Ubiquitous: a Discussion of Two Theories That Impact Future Learning Applications

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Abstract Mobile media break down traditional barriers that have defined learning in schools because they enable constant, personalized access to media. This information-rich environment could dramatically expand learning opportunities. This article identifies and discusses two instructional design theories for mobile learning including the major differences between those theories and other online instructional design theories. It also presents a detailed argument for the use of mobile learning in a particular case study.

Keywords Connectivism · Instructional design theory · m-learning · Mobile learning · Ubiquitous learning

Instructional design theory operates under a system of values, which help to create and empower learner-centered environments (Jonassen et al. 1999; Snyder 2009). In addition, these values leverage community synergy by co-mingling diverse parts to improve the whole, while respecting diversity through openness to all and remaining focused on problem solving through self-directed learning (Covey 1989). With the advent of Web 2.0, the world of the Internet changed dramatically for designers and users. Web 2.0 offered a wide array of possibilities for "cloud-based" computing technologies that have opened the world for instructional designers to creatively meet learning needs in virtually every discipline.

For education, Web 2.0 has allowed students and faculty to locate, assemble, modify and transfer documents and other file types all over the world, and it has increased collaborative abilities far beyond any traditional means (Anderson 2007; Holt 2011). This effort has allowed the World Wide Web to evolve from an information space to a real-time collaborative working center. Coupled with the radical evolution of the microchip and Smartphone technologies, Web 2.0 has created new learning opportunities that allow for mobile implementation that has the potential to affect positive change for learners in areas like volition and social interaction, escalating a transformation in the educational world (Alexander 2004; Holt 2011; Shih and Mills 2007).

Mobile technology holds the ability to contribute to numeracy and literacy skills, the exponential enhancement of collaborative communication and problem solving, the rapid identification of learner/worker needs, and the ability to bridge the technology gap for those who have thus far been resistant to the adoption of technology in the workplace (Wyatt et al. 2010). Attewell (2005) also discovered that mobile technologies help learners focus longer and improve self-esteem and self-confidence, while remaining in an independent learning environment where discovery can take place at the discretion of the learner. This ubiquitous shift in technology from a center-driven or server-driven set of technologies to cloud-based mobile computing has provided a number of attractive elements for learning environments (Thomas 2005; Wyatt et al. 2010). First of all, project sophistication using real time collaborative abilities is attractive to the professional learner. Also, a strong emphasis on learning and teaching attracts the educator, since equipment problems and compatibility are considerably less of an issue. Since the

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platform is already standardized, the return on investment is significant in the long run for well-designed applications (Reigeluth and An 2006).

Conversely, with the advent of these new technologies, digital and media literacy are lingering issues that affect the educator's ability to create, implement, and manipulate educational media in order to realize the learning objectives (Anderson-Inman 2009). Experimentation with new media literacies within a certain set of surroundings enables the instructor to effectively problem solve as well as sample and remix media content (Jenkins et al. 2009). In addition, workers and learners need to continuously scan their environment and shift focus to salient details, which brings a new level of process generation and dynamic modeling to the multimedia world. Nonetheless some very real needs in the area of instructional design must be addressed when planning coursework for these types of implementation (Keller 2008).

As coursework and reading materials extend cognition to a more collaborative model and as these collective intelligences navigate the flow of information across multiple modalities, the instructional design world must emphasize the foundational skills for the next generation of mobile and ubiquitous learners (Venkatesh et al. 2003). As Anderson-Inman (2009) wrote about the six "C's" of future consciousness of education, she discussed the necessary competence to exceed memorization and basic literacy and then converge through these smaller devices to a continually expanding, student-centered and cloud-based curriculum (p. 130). Anderson-Inman also saw collaboration as being the catalyst to a more productive search for information and problem solving.

Therefore, the current and evolving social and collaborative realities embrace new learning theories built on emerging forms of media and digital data processing (Siemens 2006). These theories will lead to the consideration of the amalgamation of e-learning and mobile learning technologies and thus forge a path toward a more ubiquitous format that will allow learners greater autonomy and instructors more effective control (van't Hooft et al. 2007). This ubiquitous learning (u-learning) has an even greater potential to allow learners to self-regulate their learning, solve real world problems and present their solutions using media-driven models. In addition, instructors acquire the opportunity to focus on their areas of expertise (Crowe 2007; Shih 2005).

U-learning has great implications for instructional design as there is an inevitable shift that will occur as learning becomes more ubiquitous and as transactional distances become less geographical and more philosophical and pedagogical in the classroom of the future (Moore 2007). Truly mobile phones have become a part of campus life because of the availability for students to use in both synchronous and asynchronous environments (Park 2011). Since the instructional designer's main goal is to facilitate learning, it is appropriate to place a high priority on learning theory and on understanding how design and ideology affect the learning environment (Bannert 2004). Instructional design must reflect a disciplined understanding of learning and not merely a skillful practice of design (Rothwell and Kazanas 2008). Two very different learning theories may affect the instructional designer, whose canvas includes mobile and ubiquitous delivery methods.

Mayer's Multimedia Learning Theory

Weiser (1991) stated, "The most profound technologies are those that disappear" (p. 94). For the learner this is a profound idea in that the design technology used for learning needs to provide a seamless exchange of ideas makes the process of learning less complicated and more effective. Mayer's (1997) Multimedia Learning Theory provides a framework that allows the instructional designer to deliver meaningful learning by providing a learning environment through multimedia that requires the learner to select relevant information, organize that information into a coherent representation and then integrate that representation into their existing knowledge. Successful multimedia learning takes into consideration the power of utilizing multiple modalities at the same time. The selection of words and pictures together, and the organization of sounds and images into coherent verbal and pictorial models mark what is at the heart of successful learning through multimedia (Mayer 2001). Mayer found that learners absorbed more when messages that utilized multimedia consisted of both pictures and text allowing learners to fully integrate these models into the long-term memory. This is especially true when the learner had a prior knowledge of the subject matter (Deimann and Keller 2006). Astleitner and Wiesner (2004) would also add to this theory by systematically combining it with motivation and volition in an attempt to mediate the variables that exist. By incorporating goal research, and defining volition as the mediating factor that brings energy to the intentions of the learner, Mayer's Multimedia Learning Theory now provides a robust platform for the instructional designer to use multimedia as a design and development strategy for implementation in mobile technologies (Kuhl 1985; Locke and Latham 2002; Saba and Shearer 1994; Wyatt et al. 2010).

In addition to design and development element, Mayer and Moreno (2002b) theory also addresses how using multimedia makes assumptions in the delivery of information to the learner. The computer or mobile device is viewed as a system of information delivery to learners and the role of the instructional designer is to present information to learners. To assure that the learner receives the information that is being sent via the multimedia vehicle, the theory of multimedia learning makes three critical cognitive assumptions (Park 2011). First, multimedia learning assumes that humans have separate channels

for processing visual/pictorial media and the auditory/verbal representations. This is critical to Mayer's theory because well-designed multimedia must have the capacity to deliver information that will be processed through these separate channels by the learner and result in a learning experience that is richer and longer lasting in terms of long term memory (Mayer and Moreno 2002a).

The second assumption is that any given learner only has the ability to actively process a few pieces of information at any one time in each of these channels (Sweller 1999). The avoidance of cognitive overload is a critical consideration in the design and delivery of multimedia information. Germane cognitive load leads to the most effective learning effort where the learner processes and comprehends provided information. The intrinsic cognitive load caused by the complexity and structure of the material must be considered so that the presentation of the information does not result in the inability of the learner to assimilate the information (Sweller 1994). In sophisticated multimedia environments and applications, where cognitive load is increased, instructional designers will have to be prescriptive in their attempts to balance extraneous cognitive aspects that will affect the overall ability for learners to be successful in completing the learning objectives (Bannert 2004). In addition to cognitive load issues, there are also several other obstacles that the instructional designer must be aware of when designing learning for multimedia delivery.

The Serendipity Effect occurs when a learner comes across an unforeseen and interesting item of information by chance (Kuhl 1985). This happens when the learner is weak in processing the information that is being presented and/or unfocused and susceptible to an interesting distraction that interrupts the flow of information. Embedded digression problems occur when a learner takes a path that digresses from the flow of information and then loses their place or is unable to get back in alignment with the information altogether (Foss 1989). Both of these obstacles must be counteracted by actions that help focus and motivate learners as they are engaged in the learning process (Kuhl 1985).

A final obstacle to learning with multimedia is the seductive details where learners get distracted by interesting yet irrelevant aspects of a stimulus environment (Garner et al. 1989). These details can often disorient the learner so that engagement does not occur. An example of this often occurs in hypermedia environments where the enticement of extraneous linkage and other distractions cause a learner to not know where they are or where they are going, and therefore become disengaged (Deimann and Keller 2006). All of these obstacles center on a level of cognition that must be obtained and supported through the multimedia delivery.

Chandler and Sweller (1991) called this the Contiguity Principle or Split Attention Effect. They found that the effectiveness of multimedia instruction increases when words and pictures are present in a contiguous form at any given moment in time and space, and that this principle has two effects. The Temporal Contiguity effect occurs when leaning enhancements include a synchronization of visual and spoken materials and the Spatial Contiguity effect occurs when printed text and pictures are physically integrated. In addition to these principles and effects, Moreno and Mayer (1999) speak of the Modality Principle, which connects auditory narration to multimedia explanations as being superior to on screen text.

What makes Mayer's Multimedia Learning Theory critical to the instructional designer is its intuitive and historical understanding of learning in these types of environments. Today, multimedia learning encompasses many different modalities and technologies that were not available when much of the research was completed. However, even in the design of animation, simulated online gaming, and other more current uses of multimedia, Mayer's theory is not only applicable, but generally seen as the foundation on which attention cueing strategies and other realities are understood and realized in even the most current forms of multimedia authoring (Koning et al. 2009). The reality of the learner and his needs are still the same and although the delivery vehicle changes, effective learning must take into account these issues and design accordingly so that the learner is successful in reaching the objectives that are expected.

Connective Learning Theory

In his book, *The Medici Effect*, Johansson (2006) makes the most interesting of statements: "The best chance to innovate for most of us lies in intersections" (p. 20). Now by the intersections (of ideas as an example), Johansson is not simply talking about combining two different concepts into a new idea. Instead Johansson is referring to an intersection that creates space for unusual combinations to occur, and in these unusual combinations there can occur an intersectional innovation. The innovations then have the power to open up fields and directions never before seen or understood and ultimately provide a source of continual innovation for years following the initial intersection. Johansson's words ring true when one begins to understand the power and promise of Connective Learning Theory and how it will impact instructional design and education in ways that may not be realized for many years. Yet it is a representation of where the trajectory of education could intersect with the reality of the ideological and technological worlds of the next generations of learners (Marx 2006b).

With the rise of ubiquitous learning (u-learning) and its attempt to fuse the best elements and technology of e-learning and m-learning, there are several characteristics that have become associated with this next iteration of distance

learning (Sung 2009). In u-learning there is permanence, where, due to technology applications or cloud based technology, students can not lose their work unless it is purposefully deleted. Students have access to their documents and other information anytime and virtually anywhere, so that accessibility has been eliminated as a real issue for learners in u-learning models. In addition, the World Wide Web has opened up the ability for interaction with faculty and experts from anywhere in the world and the implication is that learning can happen as a part of daily life and learners can adapt easily to effectively acquire the information that they need. In short, the Internet has made education more ubiquitous and the learner more autonomous (Sung 2009).

In 1972, Bowen concluded that there were three definitive challenges to education: adequate rationale, adequate support, and an adequate pedagogy. This has made it difficult for educators in the following areas: to adequately define learning, define what kind of process there is or should be in learning in an age where digital realities are commonplace, align curriculum and teaching with the higher developments in society and connectedness and continuously reframe the discussion of transformative education where technology is the enabler of new realities of learning, thinking and being (Meizrow 2000; Siemens 2006). These issues have been and will continue to be the focus of extended research and philosophical debate. As technology continues to exponentially grow and morph, these issues will consistently be in the foreground as education moves forward for generations to come (Marx 2006a). However, it would seem that an intersection may have occurred that could help reshape our understanding of education in a more ubiquitous world by looking at learning not as residing in the mind of an individual, but in a distributed manner across a network (Siemens 2006). Thus, Connected Learning Theory comes clearly into view.

Connective Learning Theory presents learning as a series of connections within the process of forming networks that work together to solve problems and think in differ ways. This is accomplished in communities of networks where practical learning is a result of participating in the community itself (Downes 2006). Connective knowledge can then be defined as diverse, autonomous, interactive, and open to anyone who wants to learn and participate (Downes 2007). A learning activity can then be as complex as a simulation that a community participates in together, or as simple as a conversation between learners and other community members. The popularity of these types of conversations has grown in the social media networks, through blogs, wikis, podcasts and video blogging.

There is an inherent gap created by Constructivism that points to the reality that knowledge and truth can occur through many diverse, objective, subjective and pragmatic means and that it is possible where learning could occur through a rich environment that was purposed to create a complex system of learning diversity (Siemens 2005). In these regards, Connective Learning Theory views learning as being more involved than the sharing of raw data, or a mere association with a process. However there is a deeper ideology that tries to understand and is centered on the question, "What is knowing?". For the connectivist, knowing is centered in networks made up of nodes that are all engaged in a flow of information that will help the network find solutions to problems or tackle ideological issues from a diverse set of perspectives and world views (de Waard 2011).

This has huge implications for instructional design in that the objective of design now is to create environments where these connections can be made without the tightly structured reality that has been the norm. The instructional designer now becomes the facilitator of a specific community building plan where an infrastructure is set up so that different nodes can all meet and begin the network forming process so that information can begin to flow between the networks. In many ways this looks much like an e-learning model, however the difference is that the control of the learning is in the hands of the learners themselves (Jenkins et al. 2009). Facilitators are an important part of the process. They help guide the community, keep it focused and motivated and aggregate the conversations so that the community's connections and information are archived for later retrieval.

Keller (1987) created the ARCS model which speaks to the motivation of learners and Connective Learning Theory is built on the idea that the elements of this model will be amplified through relevant, confident, and self-regulated connections use logic, patterning and experience to gain relevance for the other members of the network and community (Siemens 2006). Networked learning can then be defined and established on several basic principles by Siemens (2006) and Downes (2006). Learning and knowledge rests in the diverse opinions that are present in a given network. A node (intersection) is any element that can be connected to another element and can consist of raw data, information, knowledge, or meaning. Thus, learning becomes a process of connecting a set of specialized nodes in a common network for a common set of goals. This allows for the ability to now be more critical than what was currently known (Siemens 2006).

The hope is that knowledge for everyone in the community will expand and remain current for the sake of continuing to build learning on the most accurate information. The skill in this learning theory is the ability to see these connections between fields, ideas, and concepts in a way that will lead to the facilitation of networks and building of communities. Finally, connectivism sees decision-making as a principle of learning (de Waard 2011). Self-regulation and the ability to choose what one learns, helps in the motivation of that learning and the maintenance of incoming information as seen through a lens that understands shifting realities.

Now of course, Connected Learning Theory is not without its detractors. Verhagen (2006) questioned if connectivism was a theory or pedagogy. Verhaagen also questioned if the principles advocated by connectivism were present in other learning theories, and finally took issue with Siemens' idea that learning could occur in non-human applications. Among the responses to these critiques was Downes' statement that "to know something is to be organized in a certain way and to exhibit patterns of connectivity. To learn something is to acquire those patterns" (Downes 2005, Section O para. 2). Thus the Connective Learning Theory has created a foundation by which research and study can begin. However it is a theory where the intersection of ideas and clear understanding of social activity utilizing technology will benefit the instructional design world as its continues to battle its way through emerging technologies, growing and expanding learning environments and social interactivity that is ever increasing using mobile technologies (Keller 2008). Connective Learning theory helps to make sense of the connections that are occurring through the use of mobile technology and has the potential to help empower the use of mobile technology in ways that will build on the connective platforms that already exist.

The Cultivation of Mobile Learning for a Small Firm

A small firm located in central Florida is resourcing a notable program to take a leadership role in the staff development of engineers, architects, and general contractors in the hidden risks that surround building "green," and how to manage moisture and mold issues in the context of new reform to build more environmentally friendly structures. In a series of more than fifty articles and presentations published and presented by three key shareholders of the company over the last 3 years, this firm has concluded that after reviewing the designs of hundreds of buildings over a 20 year period and observing the failures of such buildings, that these failures can be categorized generally into three major categories: building commissioning, new materials, and increased building ventilation (Odom et al. 2008).

The mission and vision of the firm is to create a sustainable model of leadership in three specific categories. First, the firm wants to continue to be the industry leader in building forensic consulting, technology, and litigation support. Second, the firm wants to be known as an educational leader for all construction, architecture and engineering professionals to help successfully navigate the new Leadership in Energy and Environmental Design (LEED®) system and green initiatives that will affect new construction and design through various entities like American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE), and the Construction Specifications Institute (CSI). To this end, the firm has established resources, funding and even new hires that will allow for these transitions.

As the new LEED® requirements for buildings are written into building codes and other areas, it is pertinent that these issues be addressed and that professionals are aware of the hidden risks so that they can design, plan and build appropriately. The firm has had an incredible response to the publication of several articles addressing these issues and the authors have traveled extensively to speak on these and other LEED® intensive subjects at some of the nation's most prestigious conferences, but it is becoming critical that this educational information be reissued in such a way that is more lucrative for the firm and less expensive for the professionals who need continuing educational units (CEU's). Ultimately, the firm wants to position itself as one of the top building forensics firm in the United States with offices in strategic areas of the country and experts that focus on the issues that are typical for that region in the area of building forensics.

With the decline in building construction over the past 3 years, the firm has been affected by the traditional building model and is now forced to look at the new LEED® requirements and shift their focus more to Green Building Initiatives. This poses a distinct set of problems in the sense that all of the professionals, both consultant and field workers, need to become more acutely aware and trained of the new standards so that our consulting work can continue especially in buildings that have problems in the future. Here is where the mobile learning model is the key to understanding the impact of education in these communities (Pescarmona 2010).

Through m-learning, these professionals can begin to utilize these ideas quickly and then local chapters of varying professions can host experiential events where a more hands on approach can be instituted at the local level given the demands of that locale and its unique factors such as weather, building codes, humidity, etc. Fundamentally the firm stands poised to position itself as a leader in the virtual proliferation of information for CEU's and this will help to redefine the education of the local chapters and take the pressure off of smaller groups to disseminate the plethora of information that is being produced about these "green initiatives." (Park 2011). The firm has established itself as a cutting edge in its ability to utilize technology to prevent and also diagnose building failures. However, with a downturn in construction, the firm is finding it more difficult at the moment to keep up with changing technologies. Also with the downsizing of the staff, there are many personnel that need critical training in order to sufficiently fill the gaps left by some who are now no longer with the firm.

In the area of image building (marketing) three immediate goals have been established; first, the website and all coordinating marketing materials need to be reworked and designed to reflect a knowledge based and not just a firm profile. This includes the creation of a mobile website as a companion to the website for the sake of clients who connect through mobile

devices. Second, a focused effort to publish articles in expanded genres and over a broader national spectrum needs to be accomplished for the further development of the firm's profile on a national level. This will include presentations, seminars, webinars, and various forms of media that will be available through a variety of means including e-learning and m-learning platforms.

Finally, a reworking of all branding for deliverables will be launched. This will include branding layouts for reports, technical memos and all forms of client communication as well as interior communications to be more media friendly and mobile media accessible. This will also include a robust intranet for employees and clients and a systemized delivery system of certain repeatable aspects of the graphic design and report production of the firm. In addition the firm is investing funds into a professional development platform that will allow through e-learning and m-learning to become providers of materials centered on the expertise of our principles for production into the mainstream construction, engineering and architectural markets for professional development. The firm is committed to being among the top leaders in their respective communities and to utilize the means that are not only necessary, but also convenient and powerful for delivery and connection within their own infrastructure of employees, but also to the general community of scholars and practitioners in their industry.

The firm believes that as technology advances, the firm must embrace these changes for the sake of keeping their knowledge center alive in the marketplace. Therefore the firm is working on initiatives with several accrediting agencies and experts to continue to provide cutting edge materials through mobile delivery and other means of future engagement (Crowe 2007). This is critical especially in a consulting industry where experts and practitioners are mobile and fluid the majority of the time, which makes it difficult for learning to occur in a more formal setting. As well, the expense of conventions has become problematic for most firms even though conventions offer the ability to fulfill all of the necessary requirements of currency in licensing, it is simple a financial imposition for most consulting firms. Using m-learning will help to continuously connect with people in the field and give them a platform to continue their professional development no matter where they are or when it is convenient for them to connect (Reigeluth and An 2006).

Conclusion

These two theories are very different from each other in the sense that Mayer's Theory speaks to the creation of information delivery to mobile devices and Connective Learning Theory speaks to the utilization of technology as a tool of connection. However in tandem they could be powerful partners in establishing communities and guiding learning in those communities (Venkatesh et al. 2003). Learning through mobile technology will be more powerful if connections can be established in conjunction with the utilization of the mobile medium for information delivery. M-learning implementations have included simple applications like podcasting and wireless access to online resources, and more complicated multimedia-learning environments that are pushed out through mobile technology. Whatever the content, mobile learning has proven to be able to support active, educational experiences that include fieldwork, interactivity in lectures, synchronous and asynchronous learning elements that connect learners to each other for the sake of collaborating and data point delivery (Dyson et al. 2009). This makes the intersection of Multimedia Learning Theory and Connective Learning Theory a vertex in m-learning as a delivery vehicle and platform for learner connection and collaboration, thus creating a more ubiquitous learning environment (Siemens 2006; Sung 2009).

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