The Optimization of E-Learning

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Abstract

In 2011, the Chapman Alliance reported an average development ratio for blended learning of 49:1 hours, averaging (without outsourcing or creation of new content) $3,938 per hour of instruction. If the cost of instruction drastically improved effectiveness, the numbers might be defensible. But, according to Merrill (2008), the effectiveness of instruction has actually decreased. This paper will: 1) Consider factors that contribute to the efficiency and effectiveness of e-Learning solutions; 2) Review the current state of instructional design relative to e-Learning, with special focus on optimization; and, 3) Assess the suitability of the current instructional design environment for the optimization of instructional design without compromising high quality, effective instruction or user experience. Research is still needed to determine how to best measure effectiveness and to cost-effectively exploit the implementation of new standards and technologies such as Tin Can API® and LRS®.

Introduction to the Optimization of E-Learning

When instruction is the product, the perceived dependence of quality on available funds, while understandable, is ethically unacceptable (Deville, 2002). When we consider that according to Westminster College President, Michael S. Bassis (2010), "many of the factors [in education] that drive up costs add little value," we are forced to search for the factors that are come into play in creating efficient and effective education and determine which (if any) can be better managed so as to provide a more equitable and just product offering. Optimization of the instructional design process, by definition, is one area that has the potential to improve educational quality while budgets remain fixed. We will look at processes, methodologies and tools that contribute to optimization and draw conclusions as to the likelihood of achieving an optimization model that is reliable. We are specifically interested in the possibility of a model that can aid typically under-represented populations (i.e., small business, non-profit, privately funded and small institutions of higher learning, and developing nations with significantly smaller budgets) produce effective, quality e-Learning solutions without sacrificing user experience or development time. We will look at instructional design models that have historically served the industry well, and then review developments in the face of changing technologies that can expedite the e-Learning instructional design process and make the resultant e-Learning products universally accessible and deployable. We also look at some of the most promising developments affecting optimization, and highlight what we believe still needs to happen to make quality e-Learning ubiquitous in the broad market.

Literature Review

In an effort to manifest optimization as it relates to the design, development and deployment of instructional design for online learning, we must first understand optimization

within the e-Learning environment. Optimization begins with efficiency, monitors effectiveness, demands quality, and in the e-Learning environment, gives proper respect to user satisfaction. Merriam-webster.com defines optimization as: “an act, process, or methodology of making something (as a design, system, or decision) as fully perfect, functional, or effective as possible.”

Efficiency from a business perspective, as Reiser and Dempsey (2012) so eloquently phrase it, means “better, faster, cheaper” (p. 183). Resources [costs] such as time, labor, expertise, and money are limited, and it is imperative to select the best outcomes possible for a given input when choosing how to allocate the available resources. This principle applies to the development of e-Learning tools just as it does to any process, product or endeavor.

For purposes of this paper, e-Learning curriculum that produces outcomes consistent with stated learning objectives will be considered effective (Baker and Baker, 1992).

A third facet of optimization is quality. A product can be effective and yet be deficient in quality—in design, material, form, performance, or durability. Quality is a measurement of the excellence of all that makes up a product or service including the ability to perform the function for which it is intended (Wideman, 2002). Optimization, then, is actually an attempt to reach the maximum level of quality which includes excellence in efficiency and effectiveness.

As we look at the e-Learning development process, and strive for optimization through efficiency of process, effectiveness of product, and quality of instruction, we find buried within the effectiveness of the product one final quality to consider: user experience. User experience is critical to the success of any e-Learning curriculum and incorporates the ease with which a student navigates the LMS and subject matter; the ability of the user to feel a connection to the instructor and fellow students; and overall satisfaction with the outcomes of the instruction (Kantoglu, Torkul, & Altunisik, 2013).

Quality and E-Learning

Quality as it pertains to e-Learning has been sharply debated. In 2000, the NEA (National Education Association) and Blackboard Inc., led by the Institute for Higher Education Policy joined forces in their report, *Quality on the Line: Benchmarks for Success in Internet-Based Education*, to create a tool that can be used to measure quality (and thus ensure excellence) in e-Learning. Pulling from prior publications and articles and leading distance education institutions, the study compiled a list of 45 benchmark groups into seven categories ranging from support systems, to pedagogical processes, course development, and evaluation/assessment methodologies. Six institutions of higher learning participated in site visits and surveys; and over 100 faculty members, administrators and students were interviewed (Phipps, Merisotis, Harvey, & O'Brien, (2000)). From the results of the surveys and site assessments, a refined list of 24 Benchmarks was compiled. The benchmarks are not ranked in order of importance; however, some of the benchmarks stood out due to the effect on the optimization of the instructional design process and potential effectiveness of the instruction: 1) Guidelines for minimum standards; 2) Ability to detect and personalize content to learning styles; 3) Importance of faculty interaction; 4) Timely Feedback; and 5) Focus of assessments/evaluation.

Of particular note, in the area of Course Development, while guidelines had been written setting quality and accessibility standards for instruction design, and while learning styles are considered important in the development of courses; assessment instruments to detect learning styles were only considered somewhat important; and, their presence in the site studies was noticeably missing. Perhaps, the explanation for this lies in the fact that those surveyed believe the courses are designed to meet student needs regardless of learning styles (Phipps et al., 2000).

But, while site structure alone does not translate to quality of instruction, if the site is inflexible, and the learning methods and delivery system are standardized, student needs are not systematically being considered nor accommodated.

Also, when considering Evaluation and Assessment, there is a surprising lack of presence of standards to compare and improve learning outcomes compared to the perceived importance and presence of enrollment, cost and successful/innovative uses of technology data to evaluate the program effectiveness (Phipps et al., 2000). If our goal is optimization with a commitment to effectiveness, this presents a deficiency in thought process and a leaning toward a corporate mindset. The measure of program effectiveness should be tied to learning outcomes.

By 2006, the focus on instructional quality was beginning to increase as evidenced in the Larreamendy and Joerns' article, *Going the Distance with Online Education*, in which they ask:

> Is distance between teacher and pupil, professor and student, an insuperable difficulty? What is involved in teaching? What are its essential elements? If propinquity of the two persons concerned is essential, it is not because telling is teaching and hearing is learning, for we know that in one ear and out the other is the course that is traveled by most of what is told students unless it is arrested and fixed by more effective educational processes (p. 580).

Larreamendy and Joerns (2006) pointed out several factors that may impact quality of instruction, including the implementation of a business model that may forfeit sound pedagogical practices in the quest for efficiency. They hold that quality of instruction is based on several factors including the instructor's level of familiarity with the subject matter; a solid

understanding of the learner; knowledge and understanding of the aspects of the content that are crucial to mastery; and the ability to involve the student(s) in the learning process. Thus, while the typology of a student as customer can be helpful in gaining an understanding of how to value and view them, we cannot compromise the foundational principles of education in so doing.

User Experience

Dominici and Palumbo (2012), in their article entitled *How to Build an e-Learning Product: Factors for Student/Customer Satisfaction*, broke the rules by referring to e-Learning students as "potential customers" (p. 88). They proposed an adaptation of the Kano Model, a tool developed by Noriaki Kano (1984) in an effort to define what the optimal e-Learning solution would need to be so as to meet and satisfy user expectations. The model is derived from the theory of attractive quality, and focuses on delineating attributes of a product based on perception and impact on user satisfaction.

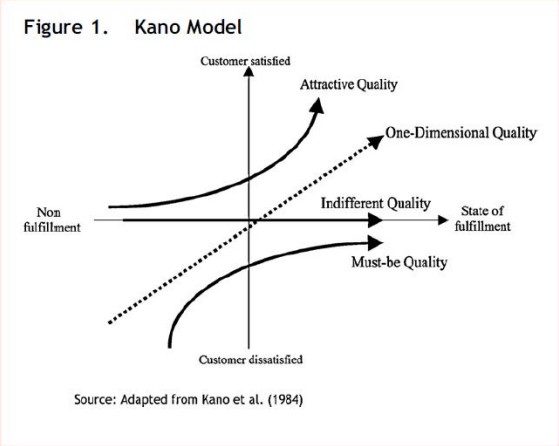

Figure 1 Kano Model measuring optimal e-Learning
Dominici, G. and Palumbo, F., 2012, p. 91.

How often when we purchase a product, we find our experience less than enjoyable. Sometimes, we find it less than acceptable. And, at the far end of the spectrum, we find it frustrating, exasperating, and downright unpleasant—perhaps even counter-productive. A discount can soften the blow; but, there is a point where even were the item free, it would have

not been worth the price one paid. Of course, there is the cliché, "You could not pay me to…" implying some things are simply not worth the negative user experience.

While the view of "student as customer" may conjure an element of disgust in some educators when we think of the sacredness of the process (although for some reason less disgust when referencing training), the analogy is nonetheless of great value when considering how to frame the importance of user experience in an e-Learning environment. We can and should take some lessons from industry. When we think of customer, we think of revenue. We understand not wanting to lose customers because that would negatively impact the bottom line. And, most would agree that it is important to provide great customer service for financial reasons alone, if not for ethical reasons. "The real aim of every business is not to supply, not to sell, or not to serve, but rather to satisfy the needs that drive customer satisfaction" (Dominici and Palumbo, 2012, p. 88).

Current Trends and Tools with Potential to Facilitate Optimization

Theoretical Framework

Dominici and Palumbo (2012) were courageous in suggesting we look at learners as *prosumers*—consumers with productive power—as Alvin Toffler (1980) envisions in his sequel to *Future Shock* entitled *The Third Wave*. They go even deeper into the corporate perspective by regarding a learner's level of "customer" satisfaction, defining it as the "gap between consumption experiences and expectations" (p. 89). Their methodology is not intended to measure course effectiveness in terms of meeting course objectives and they are quick to note the conceptual differences between "service quality and customer satisfaction" (Dominici and Palumbo, 2012, p. 89). The language indicates a movement away from a strict academic perspective, to a merging of business with academia.

While we may hesitate to look at students as customers, it is not difficult to see them as prosumers. With current Web 2.0 technologies, and the social networking phenomena, students (learners) want to and can in many cases, direct if not dictate the course of their education. They review instructors and courses and projects ad infinitum on Facebook and social networking sites, and their comments need to be considered as formative and summative evaluations in the courses we offer. Student (user) satisfaction is one key to maintaining quality in current courses and developing effective future courseware.

The Evolution of Linear ISD Models

Early models. ADDIE (1973) served the instructional design industry well with its linear progression through the stages of Analysis, Design, Development, Implementation and Evaluation (Sink, 2008). Then came Dick and Carey's 1978 Systems Approach Model which improved outcomes by focusing on objectives, creating assessments prior to the design and development of the instruction, and placing greater value on formative evaluation as a means of improving the quality of instruction earlier in the design process (Sink, 2008). Before long, there was Gerlach and Ely Instructional Model (1980), The Diamond Model (1989), Tripp and Bichelmeyer's Rapid Prototyping Model (1990), and Wedman and Tessmer's Layers of Necessity model (1991) (Edmonds et al., 1994).

Rapid prototyping and SAM. *Leaving ADDIE for SAM: An Agile Model for Developing the Best Learning Experiences* is a book written by Michael Allen and Richard Sites (2012). SAM (Successive Approximation Model) is built on the back of rapid prototyping which introduced the concept of small iterative steps through the ID process, allowing for faster deployment (ideally, weeks instead of months), ease of modification as sketches and prototypes reveal weaknesses early, and adaptability in the face of changes in a dynamic marketplace. SAM

is a non-linear, iterative process similar to the Agile software development model, promising on-time delivery within budget. Instead of waiting until the entire process is complete to reveal and deploy the product (as when using an ADDIE model), SAM instead involves the stakeholders heavily up-front in the decision-making process and allows them to see iterations of the proposed solution so they do not have to imagine what it will look like, how it will function, and what the rest of the team is imagining it to be. Below, are the graphical representations of SAM. The configuration of SAM1, in Figure 1, is suited to small projects requiring no specialized skills and using a single instructional designer or a small development team. SAM2 (Figure 2) is suitable for large projects, requiring advanced skillsets and managed by a large team of designers and

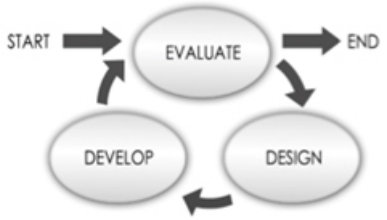

Figure 1: The instructional design process as it occurs using the single iteration of SAM1.

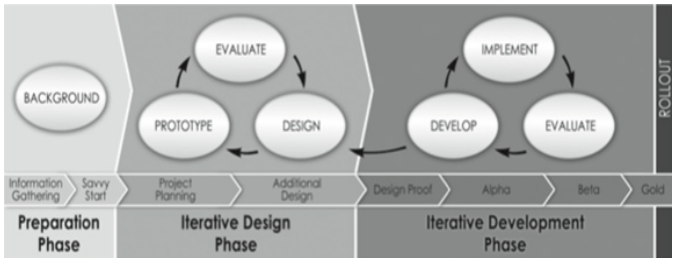

Figure 2: The instructional design process as it occurs using multi-stage Iterations of SAM2.

developers. With all of the benefits SAM brings to the table, probably the one most exciting to an instructional designer is the ability to facilitate the achievement of desired outcomes. Effective instruction that develops learner skills and improves performance can be also be produced without sacrificing efficiency, and manageable programs with an acceptable ROI can be delivered (Allen and Sites, 2012). SAM shows great promise and is “deceptively simple” as it navigates nearly every component of ADDIE and other early instructional design models; but, in a more efficient and effective way (Allen and Sites, 2012). But, what of rapid prototyping’s impact on user experience?

In *The Mythical Man, Essays on Software Engineering*, Frederick Brooks (1982) cautions that one must accept that the first effort in a large project will be virtually unusable. For that reason, he recommends planning the disposable version and introducing it early; therefore saving time, money, stakeholder frustration, and credibility. With models such as SAM, users interface with a prototypical version of the final product and communicate their reactions to it. Instructional designers and programmers adjust the model or prototype and users test it again. It is difficult for many clients and end-users to envision what they will want or need when a project begins; and the necessity of certain functionality may not be readily discernable prior to use. With traditional models, the project could be well under way before the missing functionality is discovered and what may seem to a non-programmer to be minor changes can in actuality run into thousands of dollars—if the change is even possible. Interacting with the prototype allows users to actually navigate through the interface. If an action proves difficult or an instruction seems ambiguous, changes can be quickly and easily made. The probability that deployment will be acceptable to users and meet their needs is far greater when the GUI has been tested as part of the prototype (Gordon and Bieman, 1996).

Comparing Models

Once ADDIE's reign had been challenged, what Clark (1989) called a "plethora of instructional design models and theories" (p. 59) appeared; but, he noted little research has been conducted that contrasts the models and/or theories for purposes of comparison. Edmonds, Branch and Mukherjee (1994) did develop a framework that could accommodate any instructional design model and enable an instructional designer to compare models based on parameters pertinent to the project. The Edmonds et al. framework accounts for theory, designer skill level, and context. Using it, one might find rapid prototyping paired with designing

descriptive instruction for a soft business lesson; while Interservice Procedures for Instructional Systems Development (IPISD) would be paired with "creat[ing] instruction on an institutional level (U.S. Army)" (Edmonds et al., p. 69).

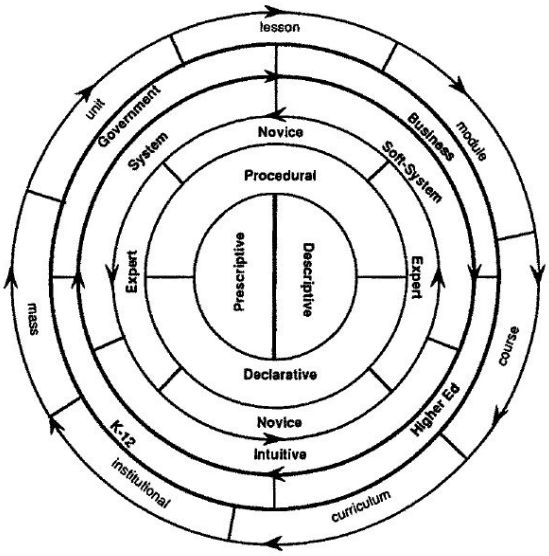

Figure 2 Conceptual framework for comparing instructional design models. Edmonds et al., 1994, p. 64.

A Quality Approach

A 2009 paper by Alptekin and Karsak entitled *An integrated decision framework for evaluating and selecting e-learning products* introduced a "methodology for evaluating and selecting e-learning products" using fuzzy regression and based on quality function deployment (QFD) which collects qualitative data about user needs and gives them quantifiable parameters so that they can be prioritized and quality methodology can be performed.

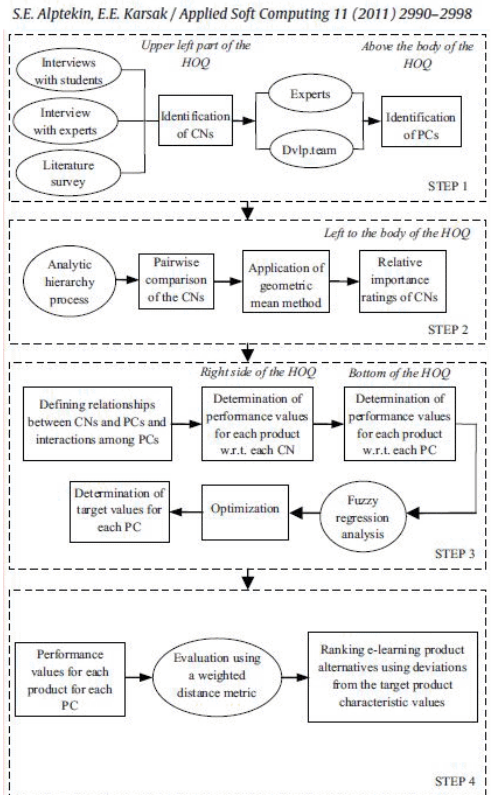

Figure 3" DQF decision framework / represents the proposed decision methodology

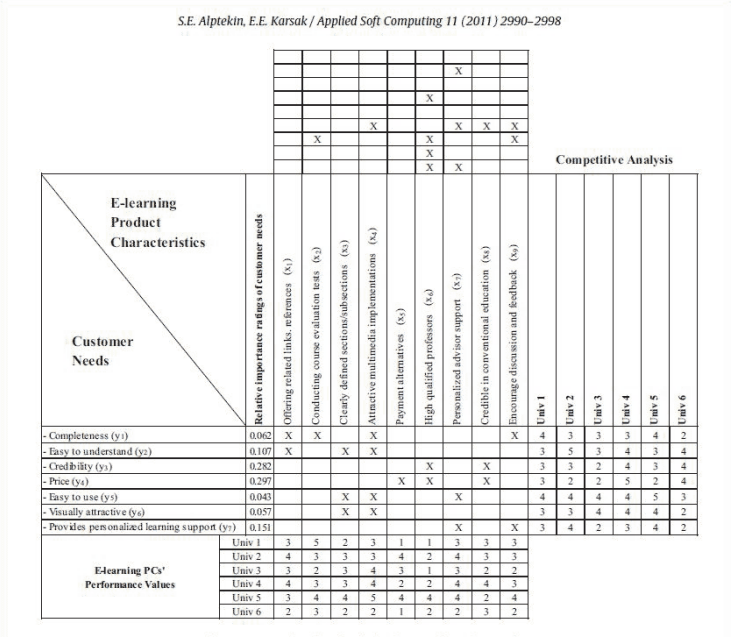

Figure 4: House of Quality (HOF) for designing an e-learning product.

The decision framework calculates the "relationships between customer needs and e-learning product characteristics" and even between the particular characteristics of the products themselves (Alptekin and Karsak, 2009, p. 2990). An example of the type of information possible is demonstrated in Table 1, below.

Solution for the linear programming formulation (8).

z^*	y_1^*	y_2^*	y_3^*	y_4^*	y_5^*	y_6^*	y_7^*	x_1^*	x_2^*	x_3^*	x_4^*	x_5^*	x_6^*	x_7^*	x_8^*	x_9^*
0.6406	3.6783	5.0000	3.2979	3.4229	3.8570	3.1443	3.3403	5.0000	3.8326	2.6353	3.2425	1.0000	1.6970	3.3326	2.8485	2.9237

Table 1: Solution for the linear programming formulation. S. E. Alptekin and E. E. Karsak, 2009, p. 2997

Note that the "z value of Univ1 is 0.5263 which is less than the optimal overall customer satisfaction degree of 0.6406." The factors that can be addressed to help improve its performance include "offering related links, references", "conducting course evaluation tests", hiring "highly

qualified professors", "providing personalized advisor support" and so forth (Alptekin and Karsak, 2009, p. 2997). This methodology offers promise for quantitatively assessing the quality of e-Learning programs and curriculum, as well as the level of user satisfaction and effectiveness of the instruction. More research is needed to determine if the initial process can be streamlined or expedited to improve overall efficiency.

Other Technologies to Watch

To increase efficiency in the instructional design process while maintaining quality, effectiveness, and user satisfaction, the selection of an ID model must become easier and more scientific. The process of designing and developing e-Learning courses must be streamlined. Parts that can be reused and shared should be. Finally, deployment must be made easier and more adaptable. Some of the new technologies are next generation rather than simple version upgrades. ADLnet.gov provides the Learning Registry®, touted as "a new approach to capturing, connecting and sharing data about learning resources available online with the goal of making it easier for educators and students to access the rich content available in our ever-expanding digital universe." Also available is ADL's 3D Repository® (which houses three-dimensional models for download) and RUSSEL®—the Re-Usability Support System for eLearning—an open source data management system for storage of courseware and artifacts with the express intent of repurposing/reusing them.

Finally—Experience API® (xAPI®) also known as TinCanAPI® (tincanapi.com). xAPI® is a fairly new industry standard that will change the way learning occurs. Part of the problem with existing learning management systems (LMS) is their inability to adapt to individual user needs, preferences and ways of learning. xAPI® enables software or systems to track things people do based on activity streams and simple Actor / Action / Object statements.

Any xAPI® enabled system has the potential to talk to all other enabled systems and/or software packages. If a learner is working on a course, and repeatedly backs out of a screen, trying a function over and over before exiting unsuccessfully, the xAPI® activity stream might read: Jenny attempted task1 > Jenny backed out of task 1 > Jenny attempted task1 > Jenny backed out of task 1. The stream is relayed to a Learning Record Store (LRS) and catalogued as a learning experience. The instructor can pull Jenny's progress report and initiate an intervention. Learning experiences can be used to serve content, track learning and achievement, detect problem areas, and much more.

Future Research

Issues of security and ethics need to be researched and measures taken to ensure rights to privacy will not be breached. With the sharing of artifacts and resources, intellectual property rights laws come into play and need to be considered as well. Research is needed to determine the most expeditious way to take the fragmented, app-like parts and construct versatile, easy to use, holistic systems for instructional designers that incorporate the new tools and technologies.

Conclusion

The future of e-Learning is bright. Technology has nearly caught up with creativity. Many of the challenges we faced even ten years ago—such as slow internet speeds, low bandwidth, limited storage, inadequate LMS, and outdated ISD models—are no longer issues. All that remains in the quest to achieve full optimization of the instructional design process is further development and refinement of the tools and technologies, and a systematic way to put it all together.

References

Allen, M., & Sites, R. (2012). *Leaving ADDIE for SAM: An agile model for developing the best learning experiences*. Alexandria, VA: ASTD Press.

Allen, M., & Sites, R. (n.d.). Book review: Leaving ADDIE for SAM, by michael allen with richard sites by jennifer neibert: Learning solutions magazine. Retrieved June 10, 2014, from http://www.learningsolutionsmag.com/articles/1012/book-review-leaving-addie-for-sam-by-michael-allen-with-richard-sites

Alptekin, S. E., & Karsak, E. E. (2011). An integrated decision framework for evaluating and selecting e-learning products. *Applied Soft Computing, 11*(3), 2990-2998. doi: 10.1016/j.asoc.2010.11.023

Alptekin, S. E., & Karsak, E. E. (2011). An integrated decision framework for evaluating and selecting e-learning products. *Applied Soft Computing, 11*(3), 2990-2998. Retrieved June 22, 2014.

Baker, S., & Baker, K. (1992). *On time/on budget: A step-by-step guide for managing any project*. Englewood Cliffs, NJ: Prentice Hall.

Bassis, M. S. (2010, March 25). Changing the equation @insidehighered. Retrieved June 22, 2014, from http://www.insidehighered.com/views/2010/03/25/bassis#sthash.EDYSsPXc.dpbs

Brooks, F. P. (1982). *Mythical man-month: Essays on software engineering*. Reading, mass.: Addison-Wesley Publishing Company.

Deville, P. R. (2002, August 1). *Equal opportunity in the educational system and the ethics of responsibility* [Scholarly project]. In *SSRN.com*. Retrieved June 22, 2014, from http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2014128

Dominici, G., & Palumbo, F. (2013). How to build an e-learning product: Factors for student/customer satisfaction. *Business Horizons, 56*(1), 87-96. doi: 10.1016/j.bushor.2012.09.011

Edmonds, G. S., Branch, R. C., & Mukherjee, P. (1994). A conceptual framework for comparing instructional design models. *ETR&D, 42*(4), 55-72. Retrieved June 10, 2014.

Foreman, S. (2013, October 14). The xAPI and the LMS: What does the future hold? by Steve Foreman : Learning Solutions Magazine. Retrieved June 10, 2014, from http://www.learningsolutionsmag.com/articles/1271/the-xapi-and-the-lms-what-does-the-future-hold

Kantoglu, B., Torkul, O., & Altunisik, R. (2013). A Study on the factors affecting student's satisfaction in e-learning: A model proposition. *Business and Economics Research Journal, 4*(1), 121-141. Retrieved June 22, 2014, from http://www.berjournal.com/a-study-on-the-factors-affecting-student%E2%80%99s-satisfaction-in-e-learning-a-model-proposition

Larreamendy-Joerns, J., & Leinhardt, G. (2006). Going the distance with online education. *Review of Educational Research, 76*(4), 567-605. doi: 10.3102/00346543076004567

Learning Registry. (n.d.). Retrieved June 10, 2014, from http://learningregistry.org/

Lee, C., Dickerson, J., & Winslow, J. (2012). An analysis of organizational approaches to online course structures. *Online Journal of Distance Learning Administration, 15*(1).

Retrieved June 3, 2014, from http://www.westga.edu/~distance/ojdla/spring151/udegbe.html

Merrill, M. D. (n.d.). Merrill on instructional design. Retrieved May 25, 2014, from https://www.youtube.com/watch?v=i_TKaO2-jXA&feature=player_embedded

Paulsen, M. F. (2009). Successful e-learning in small and medium-sized enterprises. *European Journal of Open, Distance and E-Learning*. Retrieved June 8, 2014, from http://files.eric.ed.gov/fulltext/EJ911756.pdf

Phipps, R., Merisotis, J., Harvey, M., & O'Brien, C. (2000). *Quality on the line: Benchmarks for success in internet-based distance education* (pp. Vii-33, Rep.). Washington DC, DC: The Institute for Higher Education Policy.

Support for the project provided by the National Education Association and BlackBoard, Inc.

Quality function deployment. (2014, May 21). Retrieved June 10, 2014, from http://en.wikipedia.org/wiki/Quality_function_deployment

RUSSEL. (n.d.). Retrieved June 10, 2014, from http%3A%2F%2Fwww.adlnet.gov%2Ftla%2Frussel%2F

Schechter, H. B. (2009, July). Elearn magazine: The cost of e-.earning. Retrieved June 08, 2014, from http://elearnmag.acm.org/featured.cfm?aid=1595447

Sink, D. L. (2008). Instructional design models and learning theories. In *ASTD Handbook for workplace professionals*. American Society for Training & Development. Retrieved June 10, 2014, from http://ac.els-cdn.com.ezproxy.lib.purdue.edu/S0925527308001084/1-s2.0-S0925527308001084-

main.pdf?_tid=c8e25cd8-f08f-11e3-8bbd-00000aab0f6c&acdnat=1402398789_ef32ab33e85c3994909a04e827964cb4

Tripp, S. D., & Bichelmeyer, B. (1990). Rapid prototyping: An alternative instructional design strategy. *Educational Technology Research and Development, 38*(1), 31-44. Retrieved May 24, 2014.

Welcome to 3DR. (n.d.). Retrieved June 10, 2014, from http://3dr.adlnet.gov/

Wideman, R. (2002, December 19). Wideman comparative glossary of project management terms v3.1. Retrieved June 22, 2014, from http://www.maxwideman.com/pmglossary/PMG_Q00.htm