Aesthetic Considerations in Learning:

Implications for the Design and Development of Learning Experience

Colin M. Gray

Department of Instructional Systems Technology

School of Education

Indiana University Bloomington

December 16, 2010

Abstract

The implications of John Dewey's concept of aesthetic experience are considered through a broad literature review, including potential applications to areas of learning and instructional design. Exemplars from various areas of design practice, including interface design, human-computer interaction, and instructional design are considered. Implications for designers integrating experience-based design are evaluated, in context with existing work and practice in other design disciplines. Implications for future research and practice are discussed.

Aesthetic Considerations in Learning:
Implications for the Design and Development of Learning Experience

As the discipline of instructional design has increased in rigor and method through its emergence as an independent area of research, the focus on integrated and objective communication of subject matter has diminished the relative importance of user experience in the learning process. While many practitioners in the instructional design (ID) field would acknowledge the importance of the intangible, experiential elements of the learning process, few principles or exemplars exist on which to base research or practice (Boling, n.d.; Parrish, 2005). To continue the effective practice of ID in an external environment dominated by media and marketing-saturated storytelling experiences, practitioners must consider the role of user experience in the creation and distribution of instructional materials, in order to maintain acceptable levels of effectiveness and engagement. Although there is a history of consideration that has been given to various elements of this quality of "user experience"—through visual standards, aesthetic principles, visual semiotics, or human-computer interaction—a holistic view of experience has not been traditionally pursued within the ID field. This review seeks to locate resources within the traditional ID context that may find application in the design and development of a quality and effective user experience, although sources may be derived from other design disciplines where warranted, or where principles or practices may define the process of the designer or design process in helpful contrast.

Definitions

To approach a topic as complex as aesthetics within the context of learning experience, definitions of various terms used throughout this review will be beneficial. According to Dewey (1934/2003) and Parrish (2007), an **aesthetic experience** is one which is heightened, immersive,

and particularly meaningful, forming a holistic event that is rendered as complete by the user or grantee of the experience. Although aesthetic experiences in this context can refer, as segments, to a wide range of elements within the learning encounter, this review will focus on visual and visually derived elements—such as navigational, iconic, or illustrative elements—of Dewey's aesthetic experience, and how these elements inform the holistic learning experience. **Visual elements** within the learning environment may include essential learning objects, but can also refer to persistent or temporal navigation or user interface (UI) elements that, through their presence, contribute to the overall learning experience and imbue meaning to the learning process.

Summary

Through the lens of John Dewey, a prominent educational scholar and philosopher, a sense of experience within learning is indivisible from the broader human experience. As Alexander (1998) comments on Dewey's outlook, "human life is guided by a desire to experience the world in such a way that the sense of meaning and value is immediately enjoyed" (p. 3). Parrish (2005) attempts to reconcile these broad visions of aesthetic experience within the context of pragmatic aesthetics by situating the argument in the sphere of ID, noting that "in creating instructional designs, we are also in the business of creating 'refined and intensified forms of experience,' yet we avoid talking about a quality essential to enhancing that experience" (p. 9). These feelings are echoed within the communication design space through the idea of "meaning making," implying the symbiosis of data and form in the creation or design of experience (Kazmierczak, 2003). Extending this metaphor into the realm of visual semiotics, the viewer or partaker of experience and the creator or creators of that experience join in the communicative process as simultaneous interpreters and creators of meaning, which ultimately

culminates in the aesthetic experience (Kazmierczak, 2003; Lazarev, 1994; Narvaez, 2000). In fact, a semiotic analysis or perspective on the aesthetic experience would reveal that the importance or true meaning—shared by both the creator and interpreter of the experience—lies in the "interrelationships between elements—rather than their hypothetical essence—in the totality that is the visual work" (Saint-Martin, 1987, p. 183).

Practitioners of design in other fields have developed entire curricula around the idea of experience in developing and sustaining the communicative process. Buxton (2007) evaluates this concept of experience design, concluding that "physical objects are often the most tangible and visible outcomes of design, but their primary function is to engage us in an experience—an experience that is largely shaped by the affordances and character embedded into the product itself" (p. 127). Löwgren and Stolterman (2004) focus on the importance of an artifact's dynamic gestalt, and the process of forming that gestalt, concluding that the design process or "composition is about 'putting things together' in a way that makes sense and creates a whole that has a gestalt including all that is needed or desired" (p. 54). More practically, Shneiderman and Plaisant (2010) recognize the achievement of experience design in forming the field of human-interaction design through the application of behavioral and cognitive psychology and other fields to the creation of designed products, leveraging the feelings and emotions of users in pursuit of ideal design characteristics. In each of these cases, design serves as a process in which the designer can affect the ultimate user experience, or in broader terms, the pragmatic aesthetic. Johnson (2010) systematically combines many of the design guidelines and processes of other interaction designers, focusing on design rules or heuristics as the key to shaping the design process as a necessary evaluative measure, judging the result of each stage of the process and resulting design artifacts through the lens of particular principles.

Through the remainder of this review, experience within the learning context will be addressed within three primary categories, largely oriented by source and discipline: design of the learning object, design of the user interface, and the creation of an effective experience designer.

Design of the Learning Object

The instructional design component commonly known as a "learning object" has been cited as the "technology of choice for the next generation of instructional design, development, and delivery" (Wiley, 2002, p. 3). According to Wiley (2002), a learning object can be easily situated and reused in multiple learning contexts, allowing the construction of relatively small units of instruction with multiple potential uses, similar to the object-oriented paradigm of computer programming. For additional clarity, Wiley quotes the working definition of a learning object by the Learning Technology Standards Committee (LTSC) as "any entity, digital or non-digital, which can be re-used or referenced during technology-supported learning" (p. 5).

While the learning object is understood within a modular context, this review will also address integrated learning environments where modularity is not defined or expected. In many integrated learning scenarios, although the instructional design process has created a prescribed learning product, complete integration of interface, messaging, and visuals is not guaranteed (Parrish, 2009). According to Dewey's framework of aesthetic experience, even these three elements of the holistic experience do not completely define the pragmatist aesthetic; the true aesthetic experience can only be defined in the holistic sense—it is not built by the assemblage of a certain set of elements, it is recognized through its continuity and connection with the end user (Parrish, 2005; Alexander, 1998).

Extensive research by Mayer has resulted in a collection of guiding principles to be used when designing technology-based instruction. These principles have the potential to dovetail with an experience-based learning environment and associated design practice. Rouet and Potelle (2005) address issues of navigation with the technology-based learning environment, and find a significant role for navigational devices within the learning process, both to aid the learning sequence itself, as well as improve recall and transfer of information. In particular, Rouet et al. (2005) note the prevalence of hypermedia associations, as they relate to navigational constructs, in the computing environment, and how these associations tend to utilize "traditional rhetorical forms such as chapters, pages, texts, and illustrations" to signal a navigational linkage or linkage opportunity (p. 308). They also recognized the importance of audience constraints—including technical skills or availability of technology, among others—as well as prior knowledge of participants and consideration to user needs when planning a navigational intervention. Also, Mayer (2005) describes the importance of social cueing in the learning process, finding that learners perform better when a conversational verbal style is utilized. His findings indicate the importance of the interaction between the designed intervention and the end user, guarding against *carte blanche* adoption of this technique, due to a potential increase in cognitive load. Research by de Jong (2005) on the process of guided discovery in the learning process indicates similar gains in the creation of conceptual knowledge, using flexible instructional guidance embedded in the learning process itself. These guidance systems were found to be somewhat adaptive to the entry knowledge and behaviors of the user, but further performance gains in the utilization of these techniques may require additional knowledge of the needs of the individual learner.

While each of these multimedia principles was derived from research and practice, the importance of the attributes of the individual learner was found to be of importance in creating an environment that was amenable to learning. Research by both Rouet et al. (2005) and de Jong (2005) noted the importance of constraints provided by the audience through incoming knowledge or skills in the implementation of the learning intervention. Within the framework of aesthetic experience, each of these multimedia devices contributed to the overall experience generated by the learning environment, enhancing the completeness of that experience through ease of navigation, relevance of verbiage, or ease of personal discovery. The research of Kuiper, Volman, and Terwel (2005) cite similar findings in terms of navigational ease and perceived relevance when attempting to teach information literacy skills to elementary-age children.

When addressing the addition of elements to the technology-based learning environment, it is also helpful to consider the role of cognitive load in supporting the potential additional load of these elements. As described by van Merriënboer and Ayres (2005), extraneous load can be increased through the addition of "processes that are not directly necessary for learning and can be altered by instructional interventions," while germane load is related to processes essential to learning, such as schema construction and scaffolding of existing information (p. 6). While limiting extraneous load is mentioned as an important way of reconciling overall cognitive load, van Merriënboer et al. (2005) and Gog, Ericsson, Rikers, and Paas (2005) note that recent research has focused more heavily on methods to reduce intrinsic and germane load through designing instruction that corresponds with the expertise of the user, with van Merriënboer et al. (2005) concluding that "the same learning materials may have high element interactivity for low-expertise learners but low element interactivity for high-expertise learners" (p. 10). Parrish (2005) reaches similar conclusions through his analysis of Deweyan aesthetics, reiterating the

higher standing of the creation of aesthetic experience as compared to the creation of mere aesthetic qualities, observing: “emphasizing aesthetic qualities can distract us from the true goals of instruction. Aesthetic qualities are superficial, with little potential contribution to knowledge construction.” (p. 13). The conception and design of learning artifacts inevitably involves communication surrounding methods of production, visual support documentation, and the creation of final materials. Botturi (2006) utilizes a blueprint model comprised of three documentation steps, including: goal definition, action diagrams, and overview diagrams. Through this method, these standardized documentation layers provide adequate communication surrounding the design and development process. In contrast to this layered documentation model, Kirschner, Strijbos, Kreijns, and Beers (2004) approach the design of learning materials from an interaction perspective in a different context, by establishing a framework of potential technological affordances, and matching of tasks to affordances in a probabilistic view of instructional design. Usability is addressed as a necessary element of addressing affordances, monitoring whether the “system allows for the accomplishment of a set of tasks in an efficient and effective way that satisfies the user,” thereby intelligently responding to the potential needs of users in the final design process (Kirschner et al., 2004, p. 50).

Land and Hannafin (2000) move beyond the specific interaction perspective to a holistic model of authentic instruction, attempting to create authentic learning contexts while recognizing the potential for unique needs for background knowledge and scaffolding to create deep levels of understanding. This model is similar to Parrish, Wilson, and Dunlap’s (2010) notion of a holistic designed experience, driven as a learning transaction by the learner over time through their evolving experience and related learning behaviors. The scaffolding utilized in Land and Hannafin’s (2000) research bears similarity to this creation of routine and perceived learning

challenges inherent to the creation of layered aesthetic experience through the transactional approach described by Parrish et al. (2010). Tessmer and Richey (1997) advocate for the creation of an authentic learning environment by recognizing the role of context—both educational and experiential—in the learning process, noting that a contextualized learning approach creates a systemically and systemically-driven design model in which the designer might approach the instructional design process. Within the practice of creating true Deweyan aesthetic experiences, Parrish (2006 and 2009) notes several non-prescriptive principles, through which a truly holistic experience might be realized. First, create a beginning, middle, and end to the learning experience; Second, cast the learner as the protagonist of their learning experience; Third, the learning activity should set the theme for the instruction, not necessarily the content of the instruction; and Fourth, the learning context supports the immersion of the learner in the instruction (Parrish, 2009).

Design of the User Interface

The user interface is still a relatively new phenomenon, when viewed through the traditional lens of visual theory or visual semiotics. Despite an extraordinary commitment of time and energy to developing standards and methods to approach the UI of designed products, technology continues to outstrip efforts to define the field (Löwgren et al., 2004; Shneiderman et al., 2010; Wilson, 2009). What has emerged, however, is a set of heuristics and approaches with which to commence and guide the design process, recognizing the changing roles of designer and interpreter in the digital economy, with the potential for innovation from the standpoint of software, hardware, and other technological constraints.

Design is seen as a series of interconnected constraints—or barriers to direct design application or process—by Lawson (1990), in which the generator of designed content, the

domain in which the content is produced, and the function of the final materials all relate and meld to form a matrix of design constraints from which the final user experience emerges. Other design theorists note the need for new methods and procedures to solve more complex problems, focusing on the expansion of internal and external complexities inherent in human utilization of design (Jones, 1970; Isaacs and Walendowski, 2002). Schön (1990) rejects the notion of design as a pure problem solving process composed of a linear trajectory, instead utilizing generative metaphor—or "a search for ways of constructing design structures within which paths to solution may later be discovered"—to redirect the problem space, and thereby solve the problem in an indirect manner (p. 135).

A touchstone for the development of user interfaces has become the end user, which in turn recognizes the pivotal role the user continues to play in the creation of design experience. In fact, the field of human-computer interaction focuses almost entirely on the role of the end user through the whole of the design and development process, searching for the elusive quality of experience through design iteration and testing, treating the perspective of the user through usability testing to be the *sine qua non* of the design process (Krug, 2010; Buxton, 2007). To accomplish user-centered design, user testing is an integral part of the design process, shaping the experience through iteration of design, with the designer using a reflective process to constantly adapt the user experience to meet defined or emerging objectives (Löwgren et al., 2004; Shneiderman et al., 2010). However, Sless (1981) contends that most communicators are "woefully ignorant of their audience," even if they are convinced of the value of such knowledge regarding the incoming knowledge or technical skill of their intended audience—in summary, due to the experiential gap between humans, direct access to affective or conative knowledge is impractical or possibly unattainable (p. 39).

When approaching the artifact of interface itself, an alternate perspective is needed to evaluate these elements properly. While learning objects or single design artifacts are often intended to be viewed in isolation, the user interface—comprised of both navigational and global design elements—serves the design as a whole through active semiotic and semantic relationships (Saint-Martin, 1987). As such, Saint-Martin (1987) notes that these singular elements—or coloremes—are largely unperceived by the human eye or by the conscious brain, as the scanning mechanism of sight often recognizes only general groupings of objects "which lend themselves easily to iconic interpretations" (p. 9). Satzinger and Olfman (1998) discuss the potential for transfer when utilizing navigational or user interface elements across shared learning contexts, noting that a unique visual structure within a single learning environment may aid the creation of schema more than the utilization of a consistent interface across multiple learning environments. Despite the generalization of many user interface elements in the human consciousness, Alexander (1998) notes Dewey's sense of aesthetic experience, describing it as a "pervasive continuity and intense, qualitative integration of the experience as a whole that marks it off from ordinary experience, which is filled with 'distraction and dispersion'" (p. 14). Alexander (1998) continues, quoting Dewey: "we have *an* experience when the material experienced runs its course to fulfillment…such an experience is a whole and carries with it its own individualizing quality and self sufficiency. It is *an* experience." (p. 14, emphasis in original).

Combining the efforts of multiple design theorists, several important aspects of user interface design may be considered as potential heuristics when approaching the design of an artifact, especially in terms of design process. Shneiderman and Plaisant (2010) structure the design process through an iterative process comprised of: user-interface requirements, guideline

documentation, user-interface software tools, and expert reviews and usability testing. In contrast, Löwgren and Stolterman (2004) envision a more abstract process, resulting from the cyclical overlay and combining of design vision, specification, and operative image. Galitz (2002) relies on a ten-step process, largely linear, in which the designer proceeds from constraints related to client and business function, then through the formal development process using appropriate (and defined) design principles, which is concluded by user testing and potential changes, based on the test results. While Galitz (2002) provides for a user-centered testing process at the conclusion of the formal design iteration, using it as a final error-checking procedure, Krug (2010) advocates testing "as early as possible" in the design process, not waiting until a functioning prototype is available (p. 31). In this continual user-testing procedure, Krug (2010) advocates for a user experience that is generated over time within the design iteration executed through the express involvement of users, and by proxy, their experiences in using and modifying the designed object. Buxton (2007) and Schön (1983) note similar gains in the development of user experience through sketching the desired human experience; while Buxton hedges that the process of sketching is not necessarily design, he surmises that it is generally true that the "archetypal activity of design" is sketching (p. 97). Buxton (2007) also recommends the use of sketching to define interaction and experience, dealing with "time, phrasing, and feel—all attributed of the overall user experience" through the sketching process (p. 135).

Direct application of aesthetics within the computing environment has also been attempted, bridging the gap between the worlds of visual artists and engineers or computer scientists, begging the question of whether the disciplines of science and art might be combined (Grillo, 2009). Fishwick, Diehl, Prophet, and Löwgren (2005) report a unique set of case studies

examining the effect of designers and computer scientists working in tandem to develop digital artifacts. Tension surrounding the usefulness of artifacts was noted, with the artists or designers tending to favor ambiguity while the computer scientists advocated a binary approach. Potential inflexibility of resulting usability test data was also an issue, with computer scientists less likely to perceive user issues as having their basis in poorly executed design, rather blaming these behaviors on the user in question. Additional user roles are postulated to overcome these divides, including crossdisciplinarity and interdisciplinarity, where roles cross in terms of respect and understanding, or where these roles become entirely interchangeable. Isaacs and Walendowski (2002) also address this potential for conflict between designers and computer scientists as user experience is considered. Although a number of case studies are utilized to address specific issues in the development of the user interface, the metaphor of collaboration and human relationships is centric to the discussion; "when you're building technology, you're not just building a tool with features. You're building something that has a relationship with its users." (p. 11). Similarly, the design relationship during the production of an artifact shares similar constraints, relying on communication and active collaboration to bridge potential design hurdles and solve potential issues in a proactive way.

Character of an Effective Experience Designer

Through the examples of design cases both in the fields of user interface design and instructional design, it is clear that the role of the designer varies by approach, and utilizes constraints—whether positive or negative—to move the design process forward (Buxton, 2007; Narvaez, 2000; Sless, 1981). Schön (1983) notes the importance of what he terms "reflective practice," of which a portion includes reflection on design challenges. A working out of this reflective process follows with an example from the field of architecture:

> Petra presents her preliminary sketches and describes the problems she has encountered. Quist then focuses on one of these problems. He reframes it in his own terms and proceeds to demonstrate the working out of a design solution. There follows a brief interval of reflection on the demonstration to date. Quist then sets out the next steps Petra will have to undertake, including one…which leads him to try to get her to look differently at the representation of slopes. There is, finally, a coda of reflection on all that has gone before. (Schön, 1983, p. 82).

As a design practitioner, it is important to recognize the ultimate goal of final user experience, even through the lens of the design process (Parrish, 2004). In this example from Schön, a design problem is worked out using the sketching process, advocated by Buxton (2007), Krug (2010), Sless (1981), and others, in an experiential context, recognizing the constraints of the design scenario—in this case, the topographic orientation of the land—and adjusting the design solution appropriately. This reflective practice also represents an example of design collaboration—relying on the perspective of another to recognize and present solutions to defined or unrecognized problems. One of the hallmarks of a design intervention is its acceptance of change as a normal, and even expected part of the design process (Buxton, 2007; Sless, 1981). Alexander (1964) reflects: "the unselfconscious process has a structure that makes it homeostatic (self-organizing), and that it therefore consistently produces well-fitting forms, even in the face of change" (p. 38)

Barthes (1977) notes the challenge in accurately translating forms over time, concluding that "signs…transforming their signifieds into new signifiers, infinitely citing one another, nowhere come to a halt: writing is generalized. If the alienation of society still demands the demystification of languages…the direction this combat must take is no, is no longer, that of critical decipherment but that of *evaluation*." (p. 168, emphasis in original) In this example, the key lesson in which design process excels is the creation of a design sense or character which guides the design process. The evaluative lens, which this translation of signs allows, has the

potential to create significantly richer experiences, from both the standpoint of the designer during the informal and formal design process, and through the designed experience of the final user through the designed artifact (Sless, 1981).

Conclusion

Within the context of aesthetic experience, a wide range of beliefs regarding the nature of design, as well as divergent views on the appropriate outcomes from these design processes exist. Although the Deweyan vision of a truly integrated aesthetic experience may be difficult or impossible to achieve, considerable value and support for this holistic approach to experience-making may be found in action in the work and theory of alternate design disciplines (Sless, 1981; Buxton, 2007). Although the bridging of science and art is by no means complete (Grillo, 2009), the referencing of these differences with a focus on bridging gaps and creating a truly collaborative or interdisciplinary design environment promises results beyond the creation of ideal user experience (Fishwick et al., 2005;Isaacs and Walendowski, 2002).

A wide variety research might stem from this review, and extend the writings of Dewey into practice. While Parrish (2004) has already promoted research through the lens of the practitioner in creating aesthetic experience in the practical realm, research and reporting from a case study basis (Boling, 2010) could be valuable as other practitioners seek to integrate experience-based design more completely into their process. Finally, as experience design becomes more widely accepted in the educational realm, it is already an accepted and widespread goal in the areas of marketing and product development. While Dewey's goals for holistic design and practice, resulting in a true experiential transaction (Parrish, 2010) may be difficult to achieve in the short term through the educational context, similar experiences are already commonly promulgated through vehicles of mass media. Research to develop the

concepts of experience, in both the holistic and temporal sense, would serve the greater needs of the educational community as learners begin to expect immersive environments similar in quality to those already considered commonplace within the world of marketing.

References

Alexander, C. (1964). *Notes on the synthesis of form.* Cambridge, Massachusetts: Harvard Univ Press.

Alexander, T. M. (1998). The art of life: Dewey's aesthetics. In *Reading Dewey: Interpretations for a postmodern generation.* (pp. 1-22).

Barthes, R. (1997). *Image, music, text.* New York: Hill and Wang.

Boling, E. (2010). The need for design cases: Disseminating design knowledge. *International Journal of Designs for Learning*, *1*(1), 1-8.

Boling, E., & Smith, K. M. (n.d.). *The changing nature of design* [Manuscript].

Botturi, L. (2006). E²ML: A visual language for the design of instruction. *Educational Technology Research and Development*, *54*(3), pp. 265-293.

Buxton, B. (2007). *Sketching user experiences: Getting the design right and the right design.* San Francisco: Morgan Kaufmann.

Dewey, J. (2003). Art as experience. In *The later works of John Dewey, 1925-1953: Vol. 10. 1934, Art as Experience.* (Electronic ed.). InteLex Corporation. (Original work published 1934)

Fishwick, P., Diehl, S., Prophet, J., & Löwgren, J. (2005). Perspectives on aesthetic computing. *Leonardo*, *38*(2), 133-141.

Galitz, W. O. (2002). *The essential guide to user interface design: An introduction to gui design principles and techniques* (2nd ed.) [Books24x7 version]. Retrieved from http://common.books24x7.com.ezproxy.lib.indiana.edu/book/id_4883/book.asp

Gog, T. V., Ericsson, K. A., Rikers, R. M. J. P., & Paas, F. (2005). Instructional design for advanced learners: Establishing connections between the theoretical frameworks of cognitive

load and deliberate practice. *Educational Technology Research and Development*, *53*(3), pp. 73-81. doi:10.2307/30220443

Grillo, Y. A. (2009). When does art become science and science art? *Leonardo*, *42*(1), 103-104.

Isaacs, E., & Walendowski, A. (2002). *Designing from both sides of the screen: How designers and engineers can collaborate to build cooperative technology.* Indianapolis, Indiana: New Riders.

Johnson, J. (2010). *Designing with the mind in mind: Simple guide to understanding user interface design rules.* Burlington, Massachusetts: Morgan Kaufmann.

Jonassen, D. H. (2000). Revisiting activity theory as a framework for designing student-centered learning environments. In *Theoretical foundations of learning environments.* (pp. 89-121). Mahwah, New Jersey: Lawrence Erlbaum Associates.

Jones, J. C. (1970). *Design methods.* London: Wiley-Interscience.

de Jong, T. (2005). The guided discovery principle in multimedia learning. In R. E. Mayer (Ed.), *The Cambridge handbook of multimedia learning.* (pp. 215-28). New York: Cambridge Univ Press.

Kazmierczak, E. T. (2003). Design as meaning making: From making things to the design of thinking. *Design Issues*, *19*(2), pp. 45-59.

Kirschner, P., Strijbos, J. -W., Kreijns, K., & Beers, P. J. (2004). Designing electronic collaborative learning environments. *Educational Technology Research and Development*, *52*(3), pp. 47-66.

Krug, D. H. (2002). Electronic media and everyday aesthetics of simulation. *Visual Arts Research*, *28*(2), 27-37.

Krug, S. (2010). Rocket surgery made easy. Berkeley, California: New Riders.

Kuiper, E., Volman, M., & Terwel, J. (2005). The web as an information resource in K-12 education: Strategies for supporting students in searching and processing information. *Review of Educational Research*, *75*(3), pp. 285-328.

Land, S. M., & Hannafin, M. J. (2000). Student-Centered learning environments. In *Theoretical foundations of learning environments.* (pp. 1-23). Mahwah, New Jersey: Lawrence Erlbaum Associates.

Lawson, B. (1990). *How designers think: The design process demystified* (2nd ed.). London: Butterworth Architecture.

Lazarev, Y. N. (1994). The art of metadesign. *Leonardo*, *27*(5), pp. 423-425.

Löwgren, J., & Stolterman, E. (2004). *Thoughtful interaction design: A design perspective on information technology.* Cambridge, Massachusetts: MIT Press.

Mayer, R. E. (2005). Principles of multimedia learning based on social cues: Personalization, voice, and image principles. In R. E. Mayer (Ed.), *The Cambridge handbook of multimedia learning.* (pp. 201-12). New York: Cambridge Univ Press.

Narváez, L. M. J., & Fehér, G. (2000). Design's own knowledge. *Design Issues*, *16*(1), pp. 36-51.

Parrish, P. (2004). *Investigating the aesthetic decisions of teachers and instructional designers.* Annual meeting of the American educational research association, san diego, CA. Retrieved from http://homes.comet.ucar.edu/~pparrish/papers/Investigating%20Aesthetic%20Decisions_final.doc

Parrish, P. (2006). Design as storytelling. *Techtrends*, *50*(4), 72-82.

Parrish, P., Wilson, B. G., & Dunlap, J. C. (2010). *Learning experience as transaction: A framework for instructional design.* [Manuscript] Retrieved from http://homes.comet.ucar.edu/~pparrish/papers/LearnExp%20As%20Trans%20_22Aug.doc

Parrish, P. E. (2005). Embracing the aesthetics of instructional design. *Educational Technology*, *45*(2), 16-25.

Parrish, P. E. (2009). Aesthetic principles for instructional design. *Educational Technology Research and Development*, *57*(4), 511-528. doi:10.1007/s11423-007-9060-7

Rouet, J. F., & Potelle, H. (2005). Navigational principles in multimedia learning. In R. E. Mayer (Ed.), *The Cambridge handbook of multimedia learning.* (pp. 297-312). New York: Cambridge Univ Press.

Saint-Martin, F. (1990). *Semiotics of visual language.* Bloomington, Indiana: Indiana University Press.

Satzinger, J. W., & Olfman, L. (1998). User interface consistency across end-user applications: The effects on mental models. *Journal of Management Information Systems*, *14*(4), pp. 167-193. doi:10.2307/40398296

Schön, D. A. (1990). The design process. In V. A. Howard (Ed.), *Varieties of thinking: Essays from harvard's philosophy of education research center.* (pp. 110-41). New York: Routledge.

Schön, D. A. (1983). *The reflective practitioner: How professionals think in action.* New York: Basic Books.

Shneiderman, B., & Plaisant, C. (2010). *Designing the user interface: Strategies for effective human-computer interaction* (5th ed.). Boston: Addison-Wesley.

Sless, D. (1981). *Learning and visual communication.* London: Croom Helm.

Tessmer, M., & Richey, R. C. (1997). The role of context in learning and instructional design. *Educational Technology Research and Development*, *45*(2), pp. 85-115. doi:10.2307/30221388

van Merriënboer, J. J. G. V., & Ayres, P. (2005). Research on cognitive load theory and its

design implications for e-learning. *Educational Technology Research and Development*, *53*(3), pp. 5-13. doi:10.2307/30220437

Wilson, C. (2009). *User experience re-mastered: Your guide to getting the right design.* Morgan Kaufmann.

Wiley, D. A. (2002). Connecting learning objects to instructional design theory: A definition, a metaphor, and a taxonomy. In D. A. Wiley (Ed.), *The instructional use of learning objects.* Bloomington, Indiana: Association for Educational Communications & Technology.