THREE LEVELS OF PLANNED ELEARNING INTERACTIONS
A Framework for Grounding Research and the Design of eLearning Programs

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Advances in technology offer a vast array of opportunities for facilitating elearning. However, difficulties may arise if elearning research and design, including the use of emerging technologies, are based primarily on past practices, fads, or political agendas. This article describes refinements made to a framework for designing and sequencing elearning interactions originally published in 2002 based on insights gained from a decade of application across settings. The updated framework adds neurobiological research on human learning as a theoretical foundation, and further distinguishes the relationship between learning theories, instructional strategies, planned elearning interactions, and emerging technologies to guide future distance education research and practice.

There appear to be considerable discrepancies between rhetoric and practice in distance education. On one hand, much has been written about: (a) contemporary theories of human learning and their implications for education and instructional design (e.g., Driscoll, 2005; Schunk, 2012); (b) learner-centered psychological principles (APA, 1997) and examples of learner-centered instructional strategies (e.g., problem-based learning); (c) the virtues of experiential learning (e.g., Dewey, 1938; Kolb, 1984; Lindsey & Berger, 2009) and educating students in a manner that is consistent with what [science, technology, engineering and mathematics] professionals do in real life; and (d) the need to foster creativity and innovative thinking (Florida, 2002). On the other hand, we continue to see schools and teachers remunerated for high credit hour generation, and rewarded for high, and penalized for low standardized test scores that focus on the mastery of declarative knowledge. As a result,

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The Quarterly Review of Distance Education, Volume 14(1), 2013, pp. 1–16 ISSN 1528-3518

online and hybrid, as well as conventional face-to-face courses continue to focus on transmitting content information and teaching to the test, perpetuating the use of teacher-directed instructional methods.

There are additional reasons online courses remain steeped in tradition. With little time, training, and resources, educators have little recourse but to do what they know best, and for many, that means using traditional teacher-directed methods and materials. Advances in technology also continue to increase access to elearning opportunities, but do not necessarily improve the quality of the elearning experience. Learning management systems such as Blackboard, Moodle, Canvas, and Desire2Learn, along with software applications such as Dreamweaver, Captivate, and Adobe Creative Suites, make it easier for people to create and post online instructional materials. Easier, however, does not mean better. There are now far more people designing online courses and course materials, with little to no formal preparation, practice, and experience in key areas such as, but not limited to, instructional design, multimedia development, and graphic design, resulting in greater variance in the quality of online course materials and, consequently, the quality of the online educational experience.

Another challenge facing distance educators and researchers is the seemingly unlimited ways one can integrate the use of technology to facilitate the array of interactions that may be planned to facilitate elearning. New applications, based on Web 2.0 technologies and mobile computing, continue to emerge with the potential to enhance teaching and learning across settings (Ferdig, 2007; Pence, 2007; Simões & Gouveia, 2008, cited by Hartshorne & Ajjan, 2009). Literature on distance education also reveals a wide range of instructional strategies that may be used to facilitate elearning (Hirumi, 2006). Clearly, elearning is not a process that can be easily defined and readily conceived to facilitate research and development. Using emerging technologies can change the manner in which teachers and students interact with content and with each other, affording opportunities for teaching and learning that were not previously possible (Maloney, 2007). However, frameworks are necessary to help organize and apply our knowledge of research and theory, and properly integrate the use of emerging technologies to facilitate elearning.

This article describes refinements made to a framework for designing and sequencing elearning interactions based on a decade of insights gained from applying the framework in a variety of settings. It posits three primary levels of interactions that distinguish the framework and illustrate the relationship between learning theories, instructional strategies, and learner interactions with human and nonhuman resources that include the use of emerging technologies to facilitate elearning. The original framework, first published in 2002, helped educators analyze, design, and sequence elearning interactions (Hirumi, 2002a, 2002b). The second version further delineated Level II learner-nonhuman interactions by distinguishing learner-tool and learner-interface interactions (Hirumi, 2006). The third version (Hirumi, in press) elaborates on internal student-self interactions by recognizing how teams and groups of individuals may work together to construct knowledge and derive meaning during the learning process to facilitate cognition.

The framework continues to posit three basic levels of interactions and seven classes of Level II learner-human and learner nonhuman interactions. The latest version forwards the framework by including neurobiological research and theory on human learning, and elaborating on (a) the classes of Level I interactions that may be considered to drive the selection of Level II interactions, (b) the classes of Level III interactions that may be applied to guide the design and sequencing Level II interactions, and (c) the importance of aligning all three levels of interactions to guide research and practice. Over the past decade, advances in imagining technology and neuroscience research has revolutionized the way

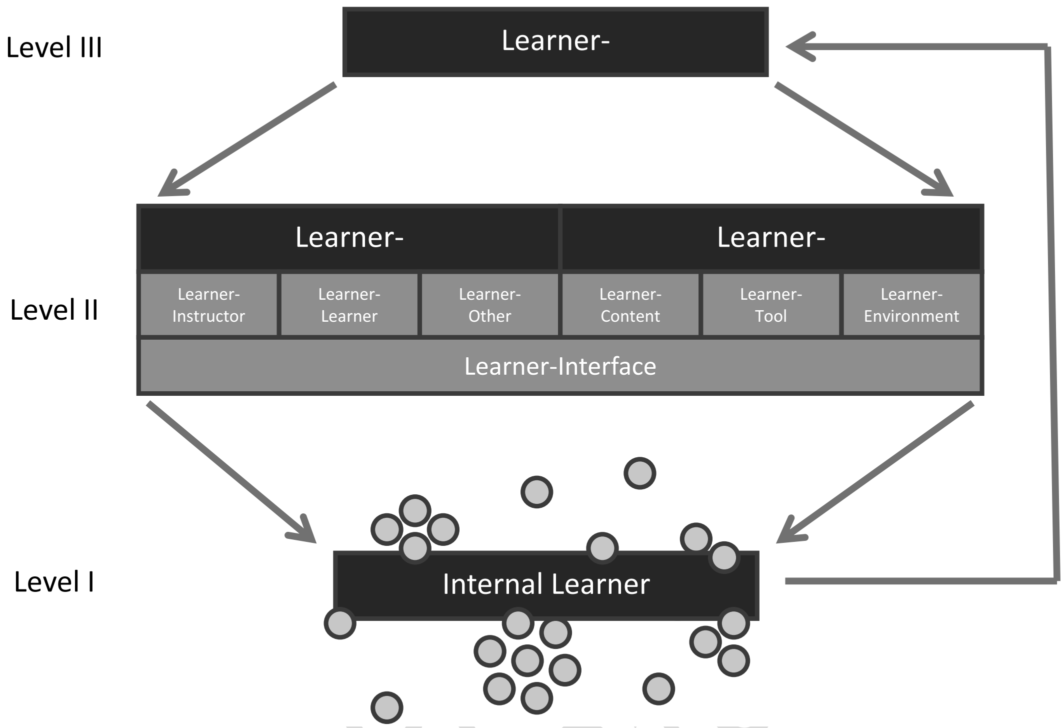

FIGURE 1
Three Levels for Planning Elearning Interactions

we treat disease states and physical traumas, and are leading to considerable insights into how and why people learn. Including neuroscience illustrates how physiological studies relate to existing psychological research and practice in human learning and instructional design. Elaborating Level I and Level III interactions further delineates the relationship between learning theories, instructional strategies, and planned elearning interactions to help organize and guide research on elearning interactions and the design of elearning programs.

THREE LEVELS FOR PLANNING ELEARNING INTERACTIONS

The framework is based on three basic premises: (a) grounding research and the design of elearning programs is necessary to systematically study and build a solid foundation for decision making and continuous improvement; (b) the alignment of theory, strategy and interactions is vital for contributing valid findings to the knowledge base, and (c) distinguishing three levels helps ensure alignment between learning theories, instructional strategies, and planned interactions.

While there is no substitute for practical experience, difficulties may occur if educators and educational researchers fail to ground their efforts in theory. When elearning strategies and the uses of technology are based on past practices, fads, or political agendas, they represent “craft-based” approaches to instruction that are carved by one person or group of people for a specific situation. This is not to say that such activities are ineffective, only that they may not be applicable to circumstances beyond those in which they are employed. Grounding research and design in theory is vital so that elearning environments may be systematically studied, continuously improved, and utilized effectively with similar populations across contexts.

Grounded design is "the systematic implementation of processes and procedures that are rooted in established theory and research in human learning" (Hannafin, Hannafin, Land, & Oliver, 1997, p.102). A grounded approach uses theory and research to make design decisions. It neither subscribes too, nor advocates any particular epistemology, but rather promotes alignment between theory and practice. Four conditions are basic to grounded design: (a) designs must be rooted in a defensible theoretical framework; (b) methods must be consistent with the outcome of research conducted to test, validate, or extend the theories upon which they are based; (c) designs must be generalizable to situations beyond the unique conditions in which they are being utilized; and d) grounded designs and their frameworks must be validated iteratively through successive implementation (Hannifin et al., 1997).

According to the three level framework, educators and educational researchers should select an instructional strategy (Level III interactions) based on their values and beliefs about how and why people learn (Level I interactions). The selected strategy should then guide the design and sequencing of elearning (Level II) interactions that are planned to stimulate or otherwise facilitate learning as defined by the designers' or researchers' (Level I) values and beliefs, bringing the process back full circle to ground elearning research and design.

Level I: Internal Learner-Self Interactions

Internal learner-self interactions consist of the mental processes that constitute learning and the metacognitive processes that help individuals monitor and regulate their learning. Internal interactions may also consist of individual assessments of self-worth, self-competence, and online presence. Such internal interactions occur as individuals work by themselves as well as when they work in pairs, and in small or large groups to facilitate learning.

Table 1 depicts major classes of learning theories, including behavioral, cognitive, constructivist, and neurobiological theories, and identifies specific theories and lines of research associated with each class. As with many taxonomies, the boundaries of each category and the classification of objects and ideas (theories in this case) are not as clear-cut as they may appear. For example, some may view Bandura's (1986, 1997, 2001) social learning theory as behavioral in principle based on its focus on modeling and measuring overt behaviors. Others may view social learning theory as cognitive because it considers the internal mental processes of attention, memory, and motivation.

Space limitations prohibit an extended discussion on the history or development of each class of learning theory. Instead, an overview of each class is provided, including references to representative theories and prominent authors, and short descriptions of key concepts and principles to distinguish each class and relate them to Level III learner-instructional interactions.

Behavioral Learning Theories. Research and the behavioral theories on connectionism (Thorndike, 1913a, 1913b, 1914), classical conditioning (Pavlov, 1927, 1928), operant conditioning (Skinner, 1938, 1953), and contiguous conditioning (Guthrie, 1942, 1952, 1959) led to many of the fundamental principles that are now associated with behavioral learning. Behavioral theories viewed learning as a process of forming associations between stimuli and responses that result in relatively permanent changes in observable behavior. Behavioral learning theorists recognized that the brain processes information but since there was no way to measure such brain activity, they chose to focus their research on measurable overt behaviors.

Basic principles associated with respondent and operant behaviors, and reinforcement contingencies characterize behavioral explanations of how and why people learn.

TABLE 1
Major Classes of Learning Theories and Related Theories and Lines of Research

Major Classes of Theories	*Related Theories and Lines of Research*
Behavioral	• Connectionism (Thorndike, 1913a, 1913b, 1914, 1932)
	• Classical conditioning (Pavlov, 1927, 1928; Watson, 1913)
	• Operant conditioning (Skinner, 1938, 1953, 1954)
	• Contiguous conditioning (Guthrie, 1942, 1952, 1959)
Cognitive	• Meaningful reception learning (Ausubel, 1962, 1968; Mayer, 1977, 2003)
	• Conditions of learning (Gagné, 1974, 1977)
	• Cognitive information processing (Atkinson & Shiffrin, 1968)
	• Schema theory (Anderson, Spiro, & Anderson, 1978; Norman, 1982; Rumelhart, 1980)
	• Social learning theory (Bandura, 1986, 1997, 2001)
	• Attribution theory (Weiner, 1985, 1986)
Constructivist	• Genetic epistemology (Piaget, 1951, 1969)
	• Gestalt (Bower & Hilgard, 1981; Koffka, 1925)
	• Sociocultural learning (Bruner, 1964, 1983, 1990; Vygotsky, 1962, 1978)
	• Situated cognition (Cobb & Bowers, 1999; Greeno, 1989; Suchman, 1987)
	• Generative learning (Wittrock, 1974, 1985, 1990)
	• Community of practice (Lave & Wenger, 1998; Wenger, 1998)
Neurobiological	• Brain-based learning (Caine, Caine, McClintic, & Klimek, 2005; Jensen, 2007)
	• Educational and cognitive neuroscience research on:
	– Emotions (Damasio, 1994; Immordino-Yang & Faeth, 2010; LeDoux, 1996).
	– Memory (Keele, Ivry, Mayr, Hazeltine, & Heuer, 2003; McClelland, 2000; Miller 2003)
	– Attention (Corbetta & Shulman, 2002)
	– Social cognition (Adolphs, 2003; Beer, 2009; Lieberman, 2007)
	– Language (Caramazza, 1996; Dronkers, Wilkins, Van Valin, Redfern, & Jaeger, 2004; Hagoort, 2005)
	– Creativity (Dietrich, 2004; Heilman, Nadeau, & Beversdorf, 2003; Neubauer, 2011)

Au: Koffka year in references is 1924 but 1925 here. Which is correct?

Respondent behaviors refer to behaviors that are elicited involuntarily in reaction to a stimulus. In contrast, operant behaviors are emitted by an organism's responses to his or her environment. Reinforcement contingencies explain how the antecedents of a response, also referred to as the contingent stimuli, either strengthen or weaken the relationship between the original (discriminative) stimulus and (operant) response.

Research, predominantly with animals and then generalized to humans, revealed a number of behavioral learning concepts and principles. Principles of operant conditioning indicate that positive and negative reinforcements may be used to strengthen a response, and how punishment and reinforcement removal may weaken a response. Behavioral research also demonstrates how shaping, chaining, discrimination learning, and fading work for teaching new behaviors (cf. Dricoll, 2005).

Cognitive Learning Theories. Frustrated with the limitations of behavioral learning theories, psychologists sought to put the "mind" back into human sciences (Bruner, 1990), leading to what is referred to as the cognitive revolution. A number of theories distinguish cognitive explanations of how and why people learn, including the theory of meaningful reception learning (Ausubel, 1962, 1968; Mayer, 1977, 2003), schema theory (Anderson et al., 1978; Norman, 1982; Rumelhart, 1998), and social learning theory (Bandura, 1986, 1997, 2001). Although their foci differ, each theory explains learning by the thought processes that govern behavior and measure changes in behavior as an indicator of internal cognitive processes. Models of cognitive information processing can be traced to Atkinson and Shiffrin's (1968) classic multistage theory of memory in which information undergoes a series of transformations before it is stored in long-term memory. The focus on the internal mental structures that process information and govern human learning and behavior distinguishes cognitive from behavioral and constructivist theories of human learning.

Constructivist Learning Theories. Constructivist learning theories assume that people construct knowledge based on their interpretations of the world. Reality is provisional and influenced by an individual's prior knowledge and experience. Like the other classes of learning theories, there is no single constructivist theory. One tradition comes from Gestalt theories of perception that focus on the ideas of closure, organization, and continuity (Bower & Hilgard, 1981). Gesalt psychologists suggest that people do not interpret pieces of information separately and that cognition imposes organization on the world (Koffka, 1925). Theories of intellectual and sociocultural development also contribute to the notion of constructivism. Developmental constructivists focus on how individuals construct knowledge through increasingly sophisticated methods of information representation and organization that are developed over time (e.g., Bruner, 1983, 1990; Piaget, 1951, 1969). In contrast, social constructivists depict learning as a socially mediated experience and concentrate on how groups construct knowledge and learn how to regulate their behaviors based on social and cultural interactions.

Au: 1924 in references.

Research on situated cognition further distinguishes constructivist views on human learning. The idea that learning is affected by interactions between the person and the situation is not unique. Emphasis on the situation, however, differentiates constructivists, who see all thoughts residing in physical and social contexts, from cognitivists who view knowledge as something that resides within the learner. Situation cognition focuses on the relationship between the person and the situation (Cobb & Bowers, 1999). Situation cognition also addresses the notion that learning involves many processes, including motivation, and encourages researchers and practitioners to recognize the value of authentic learning activities and importance of experiential learning at schools and at work as well as online.

Perhaps the principles of constructivist learning that separate it from behavioral, cognitive, and neurobiological theories of human learning are best synthesized by the APA (1997) who list learner-centered psychological principles related to (a) cognitive and metacognitive, (b) motivational and affective, c) developmental and social factors, and d) individual differences.

Neurobiological Learning Theories. In distinct contrast to cognitive and constructivist learning theories that study the psychology of learning, neurobiological theories examine physiological changes to the brain and the central nervous system that govern human cognition and behavior. Over the past 5-10 years, advances in imaging technology have led to tremendous insights into how our brain functions, revolutionizing the way we treat both trauma and disease states. Brain research on healthy mental operations is now revealing neuromechanisms associated with sensory perception, learning, memory, imagination, and emotions that are of increasing relevance for educators and instructional designers.

From a cognitive neuroscience perspective, learning is viewed as the modulation of neurons: the formation and strengthening of synaptic connections through new and repeated thoughts and actions. Further discussion of the neuromechanisms associated with human learning goes beyond the purpose of this article. Instead, learning principles and key lines of cognitive neuroscience research, along with references to books and related professional organizations are listed to further distinguish neurobiological theories of human learning and guide future research and practice.

At this point, few have attempted to synthesize neuroscience research into comprehensive theories that explain human learning, with the exception of the 12 principles posited by Caine et al. (2005), and the seven principles proposed by Jensen (2007). While comprehensive theories remain rather limited, extensive lines of educational and cognitive neuroscience research are leading to insights on how and why people learn, including but not limited to studies on human development, memory, attention, language, social cognition, creativity, and emotions (referenced in Table 1). In turn, a growing number are authoring books that compile neuroscience research findings and discuss implications for learning and education (e.g., Sousa, 2011; Willis, 2006; Zull, 2011).

Theories posit principles for explaining phenomenon and provide a foundation for predicting cause-and-effect relationships. They offer contexts for interpreting observations and bridging the gap between research and practice. Theories also help organize research findings and establish a concrete basis for decision making and continuous improvement. Without theory, research may appear to be a disorganized collection of seemingly random data, and the use of technology and the design and sequencing of elearning interactions may become reliant on individuals' intuition and experience, rather than years of research on teaching and learning. To base studies on theory, researchers must know the principles that distinguish major classes of learning theories. To make valid contributions to the knowledge base, researchers and practitioners must also select and apply instructional strategies, tools and techniques, and design elearning interventions that are consistent with specified learning principles.

Level III: Learner-Instructional Interactions

Consistent with Driscoll's (2005) definition of instruction, learner-instruction interactions involve a deliberate arrangement of events to promote learning and facilitate the achievement of a set of learning objectives specified for an instructional unit, module, or lesson. The selection of an instructional strategy should be based on the designer's values and beliefs about how and why people learn (Level I interactions), and the instructional events posited by the strategy should guide the design and sequencing of human and nonhuman (Level II) interactions, that include the integration of tools and media used to facilitate each event.

A number of instructional strategies (defined as a comprehensive set of instructional events necessary to achieve a set of objectives specified for an instructional unit, module or lesson), may be applied to create teacher-directed or student-centered learning environments. In addition, a number of instructional tools and techniques have been specified for facilitating learning based on different theories. Table 2 lists instructional strategies along with tools and techniques that either stem from or are associated with the four major classes of theories distinguished by the framework.

In general, behavioral and cognitive instructional strategies are considered teacher-directed because the teacher typically specifies what is learned, how it's learned and how it's assessed. In contrast, constructivist instructional strategies require learners to direct their own learning. Radical constructivists may have learners defining their own objectives and assessments, but more pragmatic strategies may have learners working with the instructor to negotiate objectives and assessments. Neurobiological strategies, tools, and techniques are considered student centered because they recognize the importance of adapting goals, strategies, and assessments based on learners' knowledge, experience, and emotions.

It is important to note that instructional strategies do not necessarily fall into distinct teacher-directed or student-centered categories based on their theoretical orientation as depicted by Table 2. The extent to which an instructional strategy is considered teacher-directed or student-centered lies on a continuum and depends on the degree to which the teacher and the student take responsibility for specifying learning goals and objectives, learner assessments, and instructional/learning strategies. In other words, one can follow an instructional strategy based on cognitive information process theories of learning, such as Gagne's nine events of instruction, but can apply the strategy in a student-centered manner by allowing students to identify relevant learning objectives and giving them the responsibility of organizing and interacting with relevant stimulus information and selecting their own projects to elicit performance. Furthermore, it is apparent that the tools and techniques listed in column 3 are not necessarily unique to a particular class of learning theory. Rather, research related to each class may support the use of similar tools and techniques across theories.

Potential adaptations made during the application of an instructional strategy and use of tools and techniques across theories highlight the importance of understanding the foundation on which they are based. For instance, conducting research with a so-called constructivist learning environment that asks learners to work together to construct knowledge, but does not situate learning tasks in their physical and social context would not lead to valid findings. Adaptations may also make it difficult to identify causes for success (or failure), or to attribute positive or negative results to a particular theory or on someone's interpretation and application of the theory. To properly ground elearning practice, and to design and conduct rigorous studies that contribute to the knowledge base, the application of strategies, tools, and techniques must be consistent with the principles associated with selected theoretical frameworks.

Level II: Learner-Human and Learner-Nonhuman Interactions

Level II interactions occur between the learner and other human or nonhuman resources. According to the three level framework, the instructional events prescribed by the selected strategy should drive the design and sequencing of Level II interactions. The seven classes of Level II interactions, depicted in Figure 1, are based on review of taxonomies for classifying distance education interactions, including communication, purpose, activity, and tool-based frameworks (Hirumi, 2002a, 2002b) and refinements made to a separate framework originally posited by Reigeluth and Moore (1999) for comparing analyzing interactions for learning.

Learner-Interface Interactions. During elearning, the graphical user interface may serve as the primary means of interaction with both human and nonhuman resources. Learners may utilize a graphical user interface to send and receive e-mail, post messages in wikis and blogs, or videoconference with the instructor and/or other learners. Learners will also use a graphical user interface to access lessons and content information posted in a learning management system. Hillman, Willis, and Gunawardena (1994) propose that a learner's degree of proficiency with a medium correlates positively with the degree of success the learner has in extracting information from that medium. Metros and Hedberg (2002) also note that poor interface design can place high cognitive demands on learners, taking their attention away from the subject matter.

Learner-Instructor Interactions. Learner-instructor interactions may be initiated by either the student or instructor during elearning. The learner may interact with the instructor to ask and respond to questions, clarify and confirm learning outcomes/objectives, explain conditions, submit assignments, complete activities, monitor and evaluate teachers' performance, etc. Instructors, in turn, may interact with learners to establish learning outcomes/objectives; provide timely and appropriate feedback; facilitate information presentation; monitor and evaluate student performance; facilitate learning activities; initiate, maintain and facilitate discussions; and determine learning needs and preferences (Thach & Murphy, 1995).

TABLE 2
Relating Instructional Strategies, Tools, and Techniques to Basic Instructional Approaches and Theoretical Orientations

Theoretical Orientation	Instructional Approach			
	Teacher Directed		Student-Centered	
	Behavioral	*Cognitive*	*Neurobiological*	*Constructivist*
Instructional strategies	• Elements of lesson design (Hunter, 1990) • Direct instruction (Joyce, Weil, & Showers, 1992)	• Nine events of instruction (Gagne, 1974, 1977) • 5 component lesson model (Dick, Carey, & Carey, 2009)	• Interplay strategy (Stapleton & Hirumi, 2011)	• Experiential learning (Kolb, 1984) • Learning by doing (Shank, Berman, & Macpherson, 1999) • Problem-based learning (Barrows, 1985) • 5E instructional model (BSCS, 2005; Bybee, 2002) • WebQuest (Dodge, 2007)
Instructional tools and techniques	• Task analysis • Behavioral objectives • Practice and feedback • Programmed instruction • Contingency contracts	• Message design • Rehearsal • Chunking • Mnemonics • Advanced organizers • Cognitive task analysis • Cognitive load • Self-regulated learning	• Emotions • Positive climate • Sleep, nutrition, and movement • Active discussions • Simulation, role-playing, and immersion • Problem-based learning • Graphics and multisensory learning	• Facilitating learning • Discovery and inquiry-based learning • Authentic/experiential learning • Collaborate learning • Cognitive apprenticeships • Scaffolding • Reflective teaching and learning

Learner-Learner Interactions. Learner-learner interactions occur "between one learner and another learner, alone or in group settings, with or without the real-time presence of an instructor" (Moore, 1989, p. 4). Learner-learner interactions help groups and individuals construct knowledge and apply targeted skills. Typically, learner-learner interactions ask students to discuss important topics by using online discussion forums to share information, opinions, and insights. More involved forms of learner-learner interactions may ask students to work together to analyze and interpret data, and solve problems.

Learner-Other Human Interactions. Learner-other human interactions enable learners to acquire information from as well as work with experts or others who may or may not be a formal part of instruction. Online courses may ask learners to communicate with others outside of class to promote knowledge construction and social discourse (Bonk & King 1998). In K-12 education, such interactions may include exchanges with teaching assistants, electronic pen pals, peer mentors, and working professionals. Learner-other human interactions may occur online or face to face depending on the location, targeted outcomes, and desired experiences.

Learner-Content Interactions. Learner-content interactions may include learners accessing audio, video, text, and graphic representations of the subject matter. Multimedia such as YouTube videos and Podcasts may also be pushed to learners' cell phone or other mobile devices to facilitate elearning. In a meta-analysis of three types of distance education treatments, Bernard et al. (2009) found that only student-content interactions contributed to higher achievement and attitudes, compared to student-student and student-teacher interactions. Similarly, in a test of Anderson's (2003) interaction equivalency theorem, Miyazoe and Anderson (2010) found that students ranked student-content interactions higher in order of importance than student-teacher or student-student interactions. Interestingly, such findings seem to be contrary to research on social presence and efforts to enhance learning by building communities of learners.

Learner-Tool Interactions. Learners may interact with tools both within and outside of the online learning environment to facilitate learning. Tools, such as electronic mail, discussion forums, chat, blogs, Twitter, and desktop video conferencing are typically integrated within learning management systems to facilitate learner-human interactions. Tools such as word processors, databases, spreadsheets, and document sharing programs may also be used to facilitate individual and team productivity. Outside of the virtual environment, learners may also be asked to use tools such as a microscope, building blocks, or other manipulatives to promote learning. Of particular interest may be tools such as video cameras and other recording devices that allow learners to generate and share their own content.

Learner-Environment Interactions. Learner- environment interactions occur when learners visit locations outside the virtual online environment. It's a common myth that in an online course all activities must occur online. Learners may be asked to seek or travel to specific locations to gather, observe, and otherwise interact with others and with external resources to complete prescribed learning activities. For example, nursing students may be asked go to a nearby hospital to refine their laboratory skills. It is true that such interactions may require considerable management. However, in some cases, learner-environment interactions may be essential for facilitating the development of specified skills and for promoting experiential learning.

APPLICATIONS OF THE THREE-LEVEL FRAMEWORK

As mentioned, the three level framework may be used to design and sequence elearning interactions as well as to organize and guide elearning research. Table 3 lists steps for applying the framework to design totally online courses

Au: This has been changed to a table as it did not meet the parameters of an APA figure.

TABLE 3
Six-Step Process for Designing and Sequencing eLearning Interactions

Step 1:	Identify essential experiences that are necessary for learners to achieve specified goals and objectives (optional);
Step 2:	Select a grounded instructional strategy (Level III interaction) based on specified objectives, learner characteristics, context, and epistemological beliefs;
Step 3:	Operationalize each event, embedding experiences identified in Step 1 and describing how the selected strategy will be applied during instruction;
Step 4:	Define the type of Level II interaction(s) that will be used to facilitate each event and analyze the quantity and quality of planned interactions;
Step 5:	Select the telecommunication tool(s) (e.g., chat, e-mail, bulletin board system) that will be used to facilitate each event based on the nature of the interaction; and
Step 6:	Analyze materials to determine frequency and quality of planned elearning interactions and revise as necessary.

(Hirumi, 2002a, 2002b, 2006, in press). The framework has also been used to design hybrid training (Hirumi, Bradford, & Rutherford, 2011) and to integrate the use of educational games (Hirumi, 2010).

Because the use of the framework to design training and educational programs is discussed in length in the cited references, the remainder of this article illustrates the application of the framework for analyzing and organizing existing research and for grounding the design of future investigations.

Analyzing and Organizing Research

In addition to designing and sequencing of elearning interactions, the three level framework may be used to analyze and organize research on interactivity and elearning, and to identify trends and issues for future study. Gaps in literature, along with trends and issues, may be found by asking questions such as: Which of the seven basic Level II interactions were addressed by the study? Was the design and sequencing of Level II interactions grounded in an explicit (Level III) instructional strategy and/or (Level I) learning theory? If so, was the design and sequencing of Level II interactions consistent with specified Level III strategy and/or Level I theory? How about the selection and integration of technology? Were they based on an explicit Level III strategy and/or Level I theory? Did the course apply more teacher or learner-centered instructional strategies? Was the instructional strategy (Level III interactions) congruent with the teachers', designers', and/or researchers' educational philosophy (values and beliefs about Level I interactions)? Several articles on elearning are analyzed to demonstrate how the framework may be used to organize findings, identify issues, and guide future research.

Two studies referenced earlier illustrate how research on elearning interactions may focus solely on Level II learner-human and learner-nonhuman interactions, and how considering Level I or Level III interactions may affect reported findings. The meta-analysis by Bernard et al. (2009) examined the relative value and strength of student-student, student-teacher, and student-content interactions in 77 studies and found that only student-content interactions contributed to higher levels of student achievement or improved attitudes. Likewise, Miyazoe and Anderson (2010) measured perceived levels of importance of 236 undergraduate students across four universities and found that learners ranked student-content interactions higher than student-teacher or student-student interactions. Based on the framework, the two may be classified as Level II studies that addressed only three of the seven Level II interactions (i.e., student-student, student-teacher, student-content). Further analysis based on the framework brings to question if the courses were distinguished by their

Level III or Level I interactions, whether student-student interactions may have been of more value in courses that applied more learner-centered strategies based on constructivist learning principles than courses that may have been more teacher-directed and based on behavioral or cognitive learning theories. Certainly, questions regarding the influence of instructional strategy and theoretical orientation on perceived levels of importance and relative impact of specific learner human and learner nonhuman interactions may be raised for future research.

Studies examining the use of emerging technologies for distance education may also be analyzed and organized using the three level framework. Some studies focus on learner-tool (Level II) interactions and how they can facilitate other Level II interactions. For example, Augar, Raitman, and Zhou (2004) compared wikis and studied their use for facilitating ice breakers. Likewise, Godwin-Jones (2003) examined the nature of blogs and wikis and discussed how they could be used by teachers to communicate current events, class notes, and assignments, and by learners to facilitate team projects.

In comparison, others study learner-tool interactions and their use in facilitating alternative Level II interactions but do so in light of explicit Level I and/or Level III interactions. For instance, Beldarrain (2006) discussed the use of emerging Web 2.0 technologies for facilitating learner-learner, learner-teacher, and learner-content interactions and grounds the application of the tools on specific constructivist learning theories, such as situated cognition and communities of practice (Level I interactions). Similarly, Bruns and Humphreys (2005) examined how a wiki was used as a part of social constructivist pedagogical practice to facilitate learner-teacher, learner-learner, and learner-content interactions and advance information and communication technology literacy.

Together, the studies (examined above) illustrate how the framework may be used to analyze, organize, and help guide future research. By analyzing the six studies, it's evident that researchers may focus on a limited set of Level II interactions, and how one type of Level II interaction may affect other Level II interactions. It is also apparent that researchers may or may not relate or otherwise ground their studies on explicit learning theories. Applying the framework to analyze additional studies may reveal trends on what specific types of Level II learner-human and learner-nonhuman interactions are being studied, as well as the specific classes of Level III (instructional strategies) and Level I (learning theories) are being used to design elearning to guide future research and practice.

SUMMARY

Published taxonomies reveal a plethora of interactions that may be used to facilitate e-learning. However, relatively little has been done to synthesize literature on—and delimit the relationships between—learning theories, instructional strategies, elearning interactions, and the use of emerging technologies. This article described continuing advancements of a framework for grounding research and the design of elearning interactions. The effectiveness of the proposed framework has been demonstrated in a number of practical situations (e.g., workshops and in the design of secondary school, undergraduate, and graduate e-learning programs), but much work remains. Further study is required to provide empirical evidence for its utility and to reduce the gap between rhetoric and practice in K-12 distance education.

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