Chapter 9

# Analyzing and Designing e-Learning Interactions

Published taxonomies give educators valuable insights into the nature and range of interactions that may be used to facilitate e-learning. However, they fail to provide practical guidelines for designing and sequencing the interactions necessary to achieve a specified set of instructional objectives. This chapter posits a three-level framework for classifying e-learning interactions and illustrates how the framework may be used to design e-learning interactions and organize research on e-learning interactions to help interpret findings and guide future studies.

Interactions are one of the most frequently discussed topics and a critical concern among distance educators (Saba, 2000). Without interactions, instruction may simply become "passing on content as it if were dogmatic truth, and the cycle of knowledge acquisition, critical evaluation and knowledge validation, that is important for the development of higher-order thinking skills, is nonexistent" (Shale & Garrison, 1990, p. 29). While many concur with such statements, some question the significance of interactions in distance education (DE). In a review of DE research, Simonson, Smaldino and Zvacek (2000, p. 61) conclude, "… similar to [media] comparison studies examining achievement, research comparing differing amounts of interaction showed that interaction had little effect on achievement (Beare, 1989; Souder, 1993)." Research is needed to support the intuitive sense that interactions are important and necessary (Moore, 1995) and effort must be made to synthesize what is known to guide research and practice.

This chapter posits a framework that delineates three-levels of e-learning interactions. It begins by examining existing taxonomies and defining the components of the proposed framework. It then illustrates how the framework may be used to (a) design and sequence e-learning interactions, (b) analyze the nature and quantity of e-learning interactions, and (c) organize existing literature on interactions.

# Existing Taxonomies

Published taxonomies for classifying e-learning interactions may be grouped into four categories: (a) communication, (b) purpose, (c) activity, and (d) tool-based taxonomies (Hirumi, 2002b).

## Communication-based Taxonomies

Communication-based taxonomies specify the sender and receiver of the interaction. Moore (1989) posits probably the most widely known taxonomy, defining three basic interactions: student–student, student–teacher and student–content.

With the increasing use of computers, Hillman, Willis and Gunawardena (1994) argued convincingly for a forth class, learner-interface interactions, where the interface acts as the means of interaction including learners' use of electronic tools and navigational aids.

Others posit additional classes of communication-based interactions. For example, Carlson and Repman (1999) define learner-instructional interactions as those between the learner and the content that utilize strategies such as questioning, feedback and clarification, and control of lesson pace and sequence.

## Purpose-based Taxonomies

An alternative approach codifies interactions based on purpose. For example, Hannafin (1989) posits five basic purposes for computer-based interactions; to (a) confirm, (b) pace, (c) inquire, (d) navigate, and (e) elaborate. To guide the selection of online instructional strategies and tactics, Northrup (2001) proposes five interaction attributes (or purposes); to (a) interact with content, (b) collaborate, (c) converse, (d) help monitor and regulate learning (intrapersonal interaction), and (e) support performance. With the emerging use of telecommunication technologies, Breakthebarriers.com (2001) identified nine purposes; to (a) communicate synchronously, (b) communicate asynchronously, (c) browse and click, (d) branch, (e) track, (f) help, (g) practice, (h) provide feedback, and (i) coach.

### Activity-based Taxonomies

Activity-based taxonomies specify the level or type of interaction experienced by learners. For instance, to guide the development of Interactive Multimedia Instruction, the Department of Defense (2001) distinguishes four levels: (a) Level 1 – Passive (student acts solely as a receiver of information), (b) Level 2 – Limited Participation (student makes simple responses to instructional cues, (c) Level 3 – Complex Participation (student makes a variety of responses using varied techniques in response to instructional cues), and (d) Level 4 – Real Time Participation (student is directly involved in a life-like set of complex cues and responses.

Others note different types of online activities and group them in three basic categories. For example, based on a wide range of literature on learning and instruction, Bonk and Reynolds (1997) list activities that may be designed to promote critical thinking, creative thinking, and cooperative learning online. Similarly, Harris (1994a, 1994b, 1994c) discusses various interactivities for information searching, information sharing, and collaborative problem-solving.

### Tool-based Taxonomies

Bonk and King (1998) take a “tools-based” approach, focusing on the capabilities afforded by various technologies to facilitate e-learning. They delimit five levels, ranging from basic to complex telecommunication tools (a) electronic mail and delayed-messaging tools, (b) remote access and delayed collaboration tools, (c) real-time brainstorming and conversation tools, (d) real-time text collaboration tools, and (e) real-time multimedia and/or hypermedia collaboration tools.

Existing taxonomies provide valuable insights into the nature and range of interactions that may be used to facilitate e-learning. However, they do not provide practical guidelines for designing and sequencing a comprehensive array of interactions necessary to facilitate e-learning. Within an instructional unit or lesson, when should the instructor interact with students and what should be the nature of these interactions? When should students interact with other students, with content information or with external resources? How should each of these interactions be designed? What tools should be used to facilitate each interaction? This chapter seeks to answer these questions by proposing a framework that may be used to analyze, design and sequence e-learning interactions.

## Three-Level Framework

The proposed framework posits three, interrelated levels of interactions that may be planned as an integral part of e-learning (Figure 1).

---

Figure 1 About Here

---

Level I interactions occur within the minds of individual learners. Level II interactions occur between the learner and human and non-human resources. Level III interactions define an e-learning strategy that guides the design and sequencing of Level II interactions that, in turn, stimulate Level I interactions. It is the alignment of Levels I, II and III that is thought to be essential for the design and sequencing of meaningful e-learning interactions and the development of sound e-learning environments.

Level I: Learner-Self Interactions

Learner-self interactions consist of the cognitive operations that constitute learning and the metacognitive processes that help individuals monitor and regulate learning. The specific operations that occur within an learner's mind depend on the epistemological beliefs of the person applying the framework. A behaviorist with a positivist epistemology may recognize that learner-self interactions occur, but may choose not to attend to them, concentrating solely on Level II and Level III interactions and how they reinforce or weaken particular overt behaviors. In contrast, for someone who believes in information-processing theories of learning, key learner-self interactions may include sensory memory, selective attention, pattern recognition, short term memory, rehearsal and chunking, encoding, long-term memory and retrieval. Alternatively, a developmental constructivist may key on learner-self interactions that result from adaptations to the environment that are characterized by increasingly sophisticated methods of representing and organizing information, and a social constructivist may focus on learner-self interactions that occur when individuals interact with their social and cultural environment.

Studies on self-regulation underscore the importance of distinguishing learner-self interactions (c.f. Zimmerman & Martinez-Pons, 1988; Zimmerman & Paulsen, 1995; Corno, 1994). Self-regulated learners may have a greater potential for success than those with relatively poor self-regulatory skills because they may not need as much prompting from an instructor or help from other learners to monitor, regulate and otherwise facilitate their learning. Fortunately, self-regulation may be learned and instruction may be designed to compensate for possible deficiencies (Corno & Randi, 1999; Iran-Nejad, 1990).

In short, the proposed framework does not adhere to any particular theory or epistemology. Level I: learner-self interactions that depict beliefs about how and why people learn and regulate their learning should, however, drive the selection of Level III interaction and the subsequent design and sequencing of Level II interactions as discussed latter in this chapter.

## Level II: Learner-Human and Non-Human Interactions

Level II interactions occur between the learner and other human or non-human resources. Seven classes of Level II interactions are presented based on a framework for comparing instructional strategies posited by Reigeluth and Moore (1999). Two recent refinements have been made to the original framework (Hirumi, 2002b). Specifically, learner-interface interactions have been repositioned to better illustrate its relationship to other Level II interactions and, like Reigeluth and Moore (1999), learner-tool interactions have been distinguished from learner-environment interactions.

Learner-Interface Interactions. During e-learning, the user interface serves as the primary point, but not necessarily the sole means, of interaction with both human and non-human resources. Attention must be place on how the interface enables learners to manipulate electronic tools, view and access content, and interact with others. Hillman, Willis and Gunawardena (1994) suggest that the extent to which a learner is proficient with a specific medium correlates positively with the success the learner has in extracting information from the medium. Metros and Hedberg (2002) also note that poor interface design can place high cognitive demands upon the learner that may take their attention away from the subject matter.

Learner-Instructor Interactions. Learner-instructor interactions are defined as student or instructor initiated communications that occur before, during and immediately after instruction. Moore (1989) characterizes learner-instructor interactions as attempts to motivate and stimulate the learner and allow for the clarification of misunderstanding by the learner. A recent study of distance educator competencies reveals seven learner-instructor interactions; to: (a) establish learning outcomes/objectives; (b) provide timely and appropriate feedback; (c) facilitate information presentation; (d) monitor and evaluate student performance; (e) provide (facilitate) learning activities; (f) initiate, maintain and facilitate discussions; and (g) determine learning needs and preferences (Thach & Murphy, 1995).

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). Typically, such interactions ask learners to work together to analyze and interpret data, solve problems and share information, opinions and insights. They are designed to help groups and individuals construct knowledge and apply targeted skills.

Assigning individuals to groups does not mean that they will work collaboratively (Johnson & Johnson, 1993). For the most part, considerations for effective learner-learner interactions are similar in traditional classroom and e-learning environments (e.g., group size, composition, goals, roles and responsibilities, tools, contact information, grading). The challenge lies in planning and managing such interactions in a meaningful manner at a distance through the use of telecommunication technologies.

Many have written about learner-learner interactions, some in context of other key interactions. Those particularly interested in learner-learner interactions are also referred to literature on cooperative learning (e.g. Totten, Sills, Digby & Russ, 1991; Slavin, 1989, 1987; Johnson & Johnson, 1986) and social constructivism (e.g., Jonassen, 1999; Vygotsky, 1978; von Glasersfeld, 1989).

Learner-Other Human Interactions. Learner-other human interactions enable learners to acquire, interpret and apply information from various resources. Increasing numbers of online courses ask learners to communicate with others outside of class to promote knowledge construction and social discourse (e.g., Bonk & King, 1998). In education, such interactions may include exchanges with teaching assistants, mentors, subject matter experts, and academic support staff. In industry, learner-other human interactions may consist of communications with workplace managers and supervisors. Learner-other human interactions may occur online or face-to-face depending on the location and configuration of the learners and the other human resources.

Accrediting agencies, such as Southern Association of Colleges (SACS), also remind us that distance learners must be afforded the same services provided to local students. During the design of e-learning programs, educators must consider how distance learners will be able to contact and garner support and services from staff, such as librarians, advisors and counselors. The pervasive use of computer technology also makes ready, if not immediate access to technical support staff essential during e-learning.

Learner-Content Interactions. Learners–content interactions occur when learners' access audio, video, text and graphic representations of the subject matter under study. Each multimedia element may present learners with content or other instructional events. The key distinction between Level II learner-content interactions and Level III learner-instruction interactions is that

Level III presents a comprehensive sequence of instructional events that comprise an instructional strategy, where as Level II interactions focus on individual events and the sender and receiver of the event.

Learner-Tool Interactions. Learners interact with tools to complete tasks both within and outside of the computer environment. Telecommunication tools, such as electronic mail, discussion forums, and chat are often integrated within learning management systems to facilitate learner-human interactions. Productivity tools, such as word processors, databases, spreadsheets and graphic applications may also be used to facilitate e-learning. Outside of the computer environment, learners may be asked to use tools, such as a microscope, to complete specified activities. Whatever the case, the use of tools during e-learning warrants consideration. Instructors and/or support staff must ensure that learners have access to required tools during and after instruction (as a learner, it can very frustrating to be trained on a software application that is not available on-the-job). Furthermore, instructors and instructional designers must take into account the prerequisite skills and knowledge necessary to use specified tools.

Learner-Environment Interactions. Learner-environment interactions occur when learners visit locations or work with resources outside the computer environment. As noted earlier, not all e-learning interactions must occur online. Learners may be asked to seek or travel to specific locations to gather, observe and otherwise use external resources to complete activities and participate in planned educational events.

Learner-environment interactions may be difficult to manage at a distance, but when necessary, they can be arranged. Like planning complex learner-other human interactions, the keys are to: (a) clearly delineate the desired learning outcomes and identify when learner-environment interactions are essential for the achievement of those outcomes; (b) plan and coordinate the interactions so that learners readily understand what is expected of them and why it is important for them to interact with their environment; and (c) integrate the event with other interactions and embed them within a sound instructional strategy to optimize the experience and ensure learners reach the specified objectives.

Level III: Learner-Instruction Interactions

Congruent with Driscoll's (1994) definition for instruction, learner-instruction interactions involve a deliberate arrangement of events to promote learning and facilitate goal achievement. Level III is considered a meta-level that transcends and are used to guide the design and sequencing of Level II interactions. Learner-instruction interactions are distinguished to illustrate how grounded instructional strategies may be used to design and sequence vital e-learning interactions associated with an instructional unit.

Educators often fail to ground their designs in research and theory (Bonk & King, 1998; Bednar, Cunningham, Duffy, and Perry, 1995). While there is no substitute for practical experience, difficulties occur when e-learning strategies are based solely on past practices. With little time, training or support, educators rely on what they know best (i.e., teacher–directed methods). Such methods, however, are often inadequate for facilitating e-learning.

In traditional classroom settings, key interactions that affect learners' attitudes and performance often occur spontaneously in real-time. Good instructors interpret students' body language, answer questions, clarify expectations, facilitate activities, promote discussions, elaborate concepts, render guidance, and provide timely and appropriate feedback. Good instructors also use their expertise to shed light on complex content matter and use their charisma to motivate and engage learners.

During e-learning, communications are predominately asynchronous and mediated by technology. Opportunities to address individual and group needs based on verbal and non-verbal cues are relatively confined. Key interactions that occur spontaneously in traditional teacher directed classroom environments must be carefully planned and managed as an integral part of e-learning.

So, how do grounded instructional strategies help guide the design and sequencing of Level II interactions? Hannifin, Hannifin, Land and Oliver (1997) define “grounded design” as “the systematic implementation of processes and procedures that are rooted in established theory and research in human learning” (p. 102). A grounded approach uses theory and research as a basis for making design decisions. It does not subscribe to or advocate any particular epistemology, but rather promotes alignment between theory and practice. A cursory review of literature on teaching methods reveals a number of grounded instructional strategies that may be classified, in general, as learner-centered, experiential or teacher-directed pedagogical approaches (Figure 2).

Figure 2 About Here

Each event associated with a strategy represents an interaction; a transaction that occurs between the learner and other human or non-human resources. The application of a grounded strategy gives educators a foundation for designing and sequencing a set of e-learning interactions based on a combination of research, theory and practical experience.

## Applying the Framework

Several applications illustrate the utility of the proposed framework for designing and sequencing interactions, and analyzing the number and nature of planned interactions.

### Designing and Sequencing e-Learning Interactions

Over successive implementations, the original process for applying the framework (Hirumi, 2002a) has evolved into five steps as listed in Figure 3.

---

Figure 3 About Here

---

The selection of an appropriate strategy is critical. It determines the nature of the e-learning environment and guides the overall planning and sequencing of e-learning interactions. It requires the instructor and/or instructional designer to consider the desired learning outcomes, learner characteristics, and contextual factors, as well as his or her own educational values and beliefs. It may also require the instructor and/or instructional designer to step out of his or her comfort zone, applying a strategy that s/he may have yet to experience.

A fundamental systematic design principle is that the nature of the desired learning outcomes should drive the instructional design process. For instance, the specific technique used to analyze an instructional situation should be based on targeted learning outcomes (Jonassen, Tessmer & Hannun, 1999). Similarly, learner assessment methods should be determined by the nature of specified objectives (Berge, 2002; Hirumi, 2002d). The same principle applies to the selection of a grounded instructional strategy.

For instance, a direct instructional strategy may be effective and efficient for training people on the use of a new photocopying machine (a relatively simple procedure). If there is basically one correct answer or one method for deriving the correct answer, learners may not have to derive meaning and construct knowledge through social discourse. In contrast, if the learning outcome requires higher-order thinking and there is more than one correct answer, or more than one way to find the answer, then learner-centered approaches that encourage learners to interact with others to help interpret, apply and otherwise construct knowledge may optimize learning.

Learner characteristics are also important to consider. In some situations, learners may have greatly varying prior knowledge of the subject matter. For example, it is not uncommon for some to begin an introductory computer course with considerable computer experience, while others may start with little to no computer skills. In such cases, a student-centered approach that allows learners to negotiate their own learning objectives, strategies and assessments based on their particular needs and interests may be useful (e.g., Hirumi, 2002c). Other key learner characteristics may include, but are not necessarily limited to learners' level of social and cognitive development and preferred learning style.

Key contextual factors, such as the number and nature of learning sites may also affect the selection of an instructional strategy. If there are over 50 students taking a course who are spread across a state and it's important to allow them to work at their own pace, a self-instructional strategy may be necessary. Self-instructional materials that help students monitor and regulate their own learning with few learner-instructor interactions may be more appropriate than a collaborative approach with a high degree of planned learner-learner and/or learner-instructor interactions. Some context may also call for the use of specific methods, such as simulations or cases, warranting the use of the simulation model or case-based reasoning as an instructional strategy.

In selecting an appropriate strategy, the instructor's educational philosophy and epistemological beliefs must also be taken into account. If the instructor believes that people derive meaning and construct knowledge through social interactions, then constructivist, learner-centered, and cooperative strategies may be best suited for designing instructional materials for his/her class. If the instructor believes people learn best by "doing," then an experiential approach may resonate with his or her educational philosophy. In cases where an instructional designer works with the instructor to create instructional materials, discussions of beliefs and values are warranted, leading to a common vision of a general instructional approach (e.g., learner-centered, experiential, teacher-directed) and then the selection of a grounded strategy.

Selecting an appropriate strategy is neither simple, nor straight-forward. Much depends on the desired learning goals and objectives, but concerns for the learner, the context and fundamental beliefs about teaching and learning also mediate the selection process. Perhaps even a stronger influence is time and expertise. With insufficient time or training, educators often revert to what they know best; that is, teacher-directed methods and materials. To select an appropriate instructional strategy, the instructor and/or designer must have the time and skills necessary to analyze key variables and consider alternative strategies. They must also have the confidence, desire and the opportunity to apply alternative strategies within the context of their work environment.

Completion of Steps 2-5 is best illustrated through an example. In short, the five steps result in an instructional treatment plan (ITP). The ITP is then used to create flowcharts, storyboards and prototypes of an instructional unit before proceeding to the production of the entire course. Table 1 depicts an ITP created by an engineering professor during a two-day workshop on designing e-learning interactions. The instructional unit and corresponding treatment plan was prepared for undergraduate engineering students with the terminal objective to write and present a feasibility report. The professor selected a WebQuest (Dodge, 1998) as the Level III interaction (or instructional strategy) because the terminal objective requires students to search the World-Wide-Web and synthesize information from at least 5 sources to prepare their report. A WebQuest was selected as the strategy because the basic task involved the use of number of pre-specified Web sites and considerable problem-solving skills.

---

Table 1 about Here

---

Column 1 lists the key events associated with WebQuests. Column 2 provides a short description of how the professor plans to operationalize each event. Italicized words represent the actual text to be posted online, plain text provides genearal descriptions and underlined words indicate links to additional information or resources.

At this stage, the amount of detail to include when describing each event is frequently questioned. The answer is, “You can do the work now or you can do the work later.” Eventually, you will have to create the images or write the words to be seen by learners. If you write general summaries at this point, significant time will be necessary later to prepare content and visa versa. In cases when a team is tasked with design and development, the more detail put into treatment plans, less time is required latter to explain designs to writers, programmers and other course developers.

Column 3 identifies the type of interaction(s) that will be used to facilitate each event based on the classes of Level II interactions posited by the framework. Does the event require learner-instructor, learner-learner, or learner-content interactions? One event may require multiple interactions. This is a good time to reflect on the quantity and quality of planned interactions to determine if an appropriate combination is being applied. How many learner-instructor and learning-learner interactions are planned? Do students have sufficient opportunities to interact with one another and with the instructor? Do learners require access to others? Are there too many learner-instructor interactions, making it difficult or impossible for the instructor to manage all of the communications? You may find that you need to go back and revise your description of one or more events, illustrating the iterative nature of the five-step process.

Column 4 denotes the specific telecommunication tools that were selected to facilitate each interaction. Although the primary delivery system may have already been selected, you may still have several options. The task is to determine the appropriate tool(s) for facilitating each interaction (defined in Column 3) within available resource constraints. Relevant questions to consider include who are the primary senders and receivers of the communications? Do learners need audio, video, text and/or graphics? Are synchronous or asynchronous communications necessary? Are the communications one-to-one, one-to-some, or one to many? What kind of budget do you have? What kind of technologies and human resources are available? How much time do you have to prepare course materials?

Analyzing Planned e-Learning Interactions

At this point in the design process, an analysis of planned interactions (Step 5) may help improve the quality of e-learning materials and reduce the need for costly revisions during program development or implementation. Web-based courses with greater interactions can be more complicated to use (Gilbert & Moore, 1998). Berge (1999), for example, found that the overuse or misuse of interactions can lead to frustration, boredom, and overload. For novice distance learners, complex interactions may cause confusion and eventual drop out. Experienced distance learners may become dissatisfied if they perceive online interactions as meaningless busy work. Furthermore, too many interactions may overwhelm the instructor. A common concern expressed by educators is that it takes far more time and effort to manage an online versus a traditional class. Two potential causes for such overload are (a) too many planned learner-instructor interactions, and (b) poorly designed interactions that require additional clarification, explanation and elaboration.

Table 2 represents a planned interaction analysis completed during the workshop of the sample treatment plan presented in Table 1.

Table 2 About Here

Column one lists each type of interactions specified in the treatment plan. Column two denotes the frequency of each type of interaction. Column three provides a brief description of the quality or nature of the interaction and column four specifies any required revisions in design or factors to consider during development, implementation or evaluation.

An analysis of each class of planned interactions reveals several issues. To start, the analysis reveals eight planned learner-instructor interactions; far too many for an instructor to handle. For each interaction, the instructor must: acknowledge receipt of the initial communication; save, organize, and track relevant documents; evaluate learners' work; generate and send timely feedback, and ensure learners receive and understand the feedback. If you multiply the effort required to manage each interaction by the number of students, and consider that the treatment plan represents just one of several units, it is readily apparent that the instructor would be quickly overwhelmed. In such cases, it may be helpful to group or eliminate interactions to reduce the total number of required communications, to group learners to reduce the number of assignments, or to automate one or more interactions so that preprogrammed responses are provided based on users' input.

The second category of planned interactions includes five learner-learner interactions. In light of the number of planned learner-instructor interactions, five learner-learner interactions may be too much. During the workshop, the professor noted that students completed similar learner-learner interactions in her face-to-face courses. However, in conventional classrooms, such interactions occur through speaking and listening, two modes of synchronous communications that take less time than reading and writing. To reduce learner-learner interaction requirements, the professor considered either grouping the interactions (e.g., requiring learners to share and discuss problem and purpose statements as two parts of one online activity) or eliminating one or more interaction.

Analysis of learner-other human interactions identifies two worth noting; potential interactions with a librarian and with other professors. Librarians must be informed with enough lead time to ensure resources are available to respond to inquiries in a timely fashion. The participation of other professors must also be solicited far enough in advance to ensure sufficient numbers are prepared to address learner inquiries.

The analyses of learner-content and learner-interface interactions illustrate the predominate use of the computer to facilitate learner-instructor, learner-learner and learner-content interactions. Such reliance emphasizes the importance of the user interface, suggesting the application of heuristic and scenario-based usability tests (c.f. Neilson, 1993), particularly if the instructor chooses not to use a commercially available learning management system for course delivery.

Analysis of the learner-environment and learner-tool interactions notes several resources that must be accessible to learners. In this case, the professor must make sure that all learners have ready access to a library, and can obtain textbooks and related journal articles in a timely fashion; processes that may take additional time to establish for distance learners. In addition, the instructor must ensure that learners have access to a word processor and presentation software (e.g., Microsoft PowerPoint[tm]), plus the skills and knowledge necessary to use the applications.

Too few, too many or poorly designed interactions can result in learner and instructor dissatisfaction, inadequate learning and insufficient performance, requiring additional time, effort and expertise to revise instruction; resources that could have been spent on other projects. Improved interface design (Metros & Hedberg, 2002) and the evolution of better Web course authoring and delivery tools may eventually make the technical aspects of online interactions transparent to learners. However, until such improvements are realized, educators must keep in mind that frequency does not equal quality (Northrup, 2001). Analysis of planned e-learning interactions specified in initial drafts of instructional treatment plans can help educators correct potential problems prior to programming, as well as identify key factors to consider during development and implementation. Such planned interaction analysis of existing coursework may also help increase the overall effectiveness of e-learning materials.

After analyzing the planned interactions, the resulting ITP is used to generate flowcharts, storyboards and/or prototypes of the instruction. To optimize design and development, rather than generating an ITP for all units that may comprise a course or training program before going into development, generate a detailed plan for one instructional unit and then immediately create flowcharts and storyboards, if necessary, and develop and test a prototype of the unit. After revising the prototype, it may then be used as a template for developing the remaining instructional units. Developing and testing one unit, and using it as a template for developing other units may significantly reduce the need for costly revisions during development or implementation.

## Summary

The creation of modern e-learning programs requires research and the development of new design methods that fully utilize the capabilities of telecommunication technologies and the potential they afford collaborative and independent learning (Bates, 1990; Mason & Kaye, 1990). This chapter posited a three-level framework for analyzing, designing, sequencing and organizing research on planned e-learning interactions. Level III (learner-instruction) interactions were viewed as a meta-level that provide educators with a grounded approach for designing and sequencing Level II that, in turn, stimulated Level I interactions that occur within the learners' mind.

Key interactions that can affect student attitudes and performance must be carefully planned and managed as an integral part of e-learning. 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, delimit the relationships between and provide practical guidelines for designing and sequencing e-learning interactions. An example illustrated how the proposed framework may be used to design and analyze planned e-learning interactions. First, an instructional treatment plan was prepared for one unit of an engineering course using the WebQuest strategy. Then, the frequency and quality of planned interactions were analyzed to reduce the need for costly revisions and optimize both the learners' and the instructor's time online. However, but much work is left. Further study is required to provide empirical evidence for its utility and to optimize the design and sequencing of planned e-learning interactions.

References

Aamodt, A. & Plaza, E. (1994). Case-Based Reasoning: Foundational Issues, Methodological Variations, and Systems Approaches. *Artificial Intelligence Communications, 7*(1), 39-59.

Bannon-Ritland, B. (2002). Computer-mediated Communication (CMC), eLearning and Interactivity: A Review of the Research. *Quarterly Review of Distance Education, 3*(2), 141-160.

Barrows, H.S. (1985). *How to design a problem based curriculum for the preclinical years*. New York: Springer Publishing Co.

Bates, A. W. (1990). *Third generation distance education: The challenge of new technology*. Paper presented at the XV World Conference on Distance Education, Caracas, Venezuela. (ERIC Document Reproduction Service No. 332 688).

Beare, P. L. (1989). The comparative effectiveness of videotape, audiotape, and telelecture in delivering continuing teacher education. *The American Journal of Distance Education, 3*(2), 57-66.

Bednar, A., Cunningham, D. J., Duffy, T., & Perry, D. (1995). Theory in practice: How do we link? In G. Anglin (Ed.), *Instructional technology: Past, present, and future* (2nd ed., pp. 100-112). Englewood, CO: Libraries Unlimited.

Berge, Z. L. (2002). Active, Interactive, and reflective learning. *Quarterly Review of Distance Education, 3*(2), 141-160.

Berge, Z. (1999). Interaction in post-secondary Web-based learning. *Educational Technology, 39*(1), 5-11.

Bonk, C. J. & King, K. (1998). Computer conferencing and collaborative writing tools: Starting a dialogue about student dialogue. In C. J. Bonk & K. King (Eds.), *Electronic*

*Collaborators: Learner-Centered Technologies for Literacy, Apprenticeship, and Discourse* (pp. 3-23). Mahwah, NJ: Lawrence Erlbaum Associates, Publishers.

Bonk, C. J. & Reynolds, T. H. (1997). Learner Centered Web Instruction for Higher-order thinking, teamwork, and apprenticeship. In B. Khan (Ed.). *Web-Based Instruction* (pp. 167-178), Englewood Cliffs, NJ: Educational Technology Publications.

Breakthebarriers.com (2000). *What is interactivity?* Retrieved March 02, 2001, from http://www.breakthebarriers.com/hottopic.html.

Bybee, R. W. (2002). Scientific inquiry, student learning, and the science curriculum. In R. W. Bybee (Ed.). *Learning Science and the Science of Learning* (pp. 25-36). Arlington, VA: NSTA Press.

Carlson, R. D., & Repman, J. (1999). Web-based interactivity. *WebNet Journal, 1*(2), 11-13.

Corno, L. & Randi, J. (1999). A design theory for classroom instruction in self-regulated learning. In C. M. Reigeluth (Ed.). *Instructional design theories and models: A new paradigm of instructional theory (Vol. II)* (pp. 293-318), Mahwah, NJ: Lawrence Erlbaum Associates, Publishers.

Corno, L. (1994). Student volition and education: Outcomes, influences, and practices. In D. H. Schunk & B. J. Zimmerman (Eds.), *Self regulation of leaning and performance: Issues and educational applications* (pp. 229-254). Hillsdale, NJ: Lawrence Erlbaum Associates, Publishers.

Department of Defense (DOD)(2001). Development of Interactive Multimedia (Part 3 or 5 Parts). MIL-HDBK-29612-3. p. 45.

Dodge, B. (1998). *The WebQuest Page*. Retrieved April 3, 2000 from the World Wide Web: http://edweb.sdsu.edu/webquest/webquest.html

Driscoll, M. P. (1994). *Psychology of learning for instruction*. Needham Heights, MA: Paramount Publishing, Inc.

Gagne, R.M. (1977). *The Conditions of Learning* (3rd ed.). New York: Holt, Rinehart, and Winston.

Gagne, R.M. (1974). *Principles of Instructional Design*. New York: Holt, Rinehart and Winston.

Gilbert, L. & Moore, D. R. (1998). Building interactivity into Web courses: Tools for social and instructional interactions. *Educational Technology*, *38*(3), 29-35.

Hannafin, M.. J. (1989). Interaction strategies and emerging instructional technologies: Psychological perspectives. *Canadian Journal of Educational Communication*, *18*(3), 167-179.

Hannafin, M.. J., Hannafin, K. M., Land, S. M., & Oliver, K. (1997). Grounded practice and the design of learning systems. *Educational Technology Research and Development, 45*(3), 101-117.

Harris, J. (1994a, February). People-to-people projects on the Internet. *The Computing Teacher*. 48-52.

Harris, J. (1994b, March). Information collection activities. *The Computing Teacher*. 32-36.

Harris, J. (1994c. April). Opportunities in work clothes: Online problem-solving project structures. *The Computing Teacher*. 52-55.

Hillman, D. C., Willis, D. J. & Gunawardena, C. N. (1994). Learner-interface interaction in distance education: an extension of contemporary models and strategies for practitioners. *The American Journal of Distance Education, 8*(2), 30-42.

Hirumi, A. (2002a). A framework for analyzing, designing and sequencing planned e-learning interactions. *Quarterly Review of Distance Education, 3*(2), 141-160.

Hirumi, A. (2002b). The design and sequencing of e-learning interactions: A grounded approach. *International Journal on E-Learning, 1*(1), 19-27.

Hirumi, A. (2002c). Student-centered, technology-rich, learning environments (SCenTRLE): Operationalizing constructivist approaches to teaching and learning. *Journal for Technology and Teacher Education, 10*(4), 497-537.

Hirumi, A. (2002d). Get a life: Six tactics for reducing time spent online. *Computers in Schools, 20(3), 73-101*.

Hunter, M. (1990). Lesson Design Helps Achieve the Goals of Science Instruction. *Educational Leadership*. *48*(4), 79-81.

Iran-Nejad, A. (1990). Active and dynamic self-regulation of learning processes. *Review of Educational Research*, *60*, 573-602.

Johnson, D. W. & Johnson, R. T. (1993). Simulation and gaming: Fidelity, feedback and motivation. In J. V. Dempsey & G. C. Sales (Eds.), *Interactive Instruction and Feedback* (pp. 133-57). Englewood Cliffs, NJ: Educational Technology.

Johnson, R. T., & Johnson, D. W. (1986). Action research: Cooperative learning in the science classroom. *Science and Children*, 24, 31-32.

Jonassen, D. H. (1999). Designing constructivist learning environments. In C. Reigeluth (Ed.). *Instructional-design theories and models: A new paradigm of instructional theory* (pp. 215-240). Mahwah, NJ: Lawrence Erlbaum Associates.

Jonassen, D. H., Tessmer, M., and Hannum, W.H. (1999). *Task Analysis Methods for Instructional Design*. Mahwah, NJ: Lawrence Erlbaum Associates, Publishers.

Joyce, B., Weil, M., & Showers, B. (1992). *Models of Teaching* (4th ed.). Needham Heights, MA: Allyn and Bacon.

Mason, R., & Kaye, T. (1990). Toward a new paradigm for distance education. In L. M. Harasim (Ed.), *On-line education: Perspectives on a new environment* (pp. 15-30). New York: Praeger.

Metros, S. & Hedberg, J. (2002). More than just a pretty (inter)face: The role of the graphical user interface in engaging online learners. *Quarterly Review of Distance Education, 3*(2), 141-160.

Moore, M. G. (1989). Editorial: Three types of interaction. *The American Journal of Distance Education*, *3*(2), 1-6.

Moore, M. G. (1995). The 1995 distance education research symposium: A research agenda. *The American Journal of Distance Education, 9*(2), 1-6.

Neilson, J. (1993). *Usability engineering*. Boston: AP Professional.

Nelson, L. (1992). Collaborative Problem-Solving. In C. M. Reigeluth (Ed.). *Instructional Design Theories and Models: A New Paradigm of Instructional Theory (pp. 241-267)*. Hillsdale, N.J.: Lawrence Erlbaum Associates.

Northrup, P. (2001). A framework for designing interactivity in Web-based instruction. *Educational Technology, 41*(2), 31-39.

Pfeiffer, J.W., & Jones, J.E. (1975) Introduction to the structured experiences section. In J.E. Jones & J.W. Pfeiffer (Eds.). *The 1975 annual handbook for group facilitators*. La Jolla, CA: University Associates.

Reigeluth, C. M. & Moore, J. (1999). Cognitive education and the cognitive domain. In C. M. Reigeluth (ed.). *Instructional-design theories and models: A new paradigm of instructional theory (Volume II)* (pp. 51-68). Mahwah, NJ: Lawrence Erlbaum Associates, Publishers.

Saba, F. (2000). Research in distance education: A status report. *International Review of Research in Open and Distance Learning, 1*(1), 1-9.

Shale, D., & Garrison, D. R. (1990). Education and communication. In D. R. Garrison and D. Shale (Eds) *Education at a Distance* (pp. 23-39). Malabar, FL: Robert E. Krieger Publishing Company.

Shank, R. C., Berman, T. R., & Macpherson, K. A. (1992). Learning by doing. In C. M. Reigeluth (Ed). *Instructional Design Theories and Models: A New Paradigm of Instructional Theory (pp. 161-179)*. Hillsdale, N.J.: Lawrence Erlbaum Associates.

Simonson, M., Smaldino, S., Albright, M. & Zvacek, S. (2000). *Teaching and learning at a distance: Foundations of distance education*. Upper Saddle River, NJ: Prentice Hall, Inc.

Slavin, R. E. (1987). Cooperative learning and the cooperative school. *Educational Leadership, 47,* 14-25.

Slavin, R. E. (1989). Research on cooperative learning: An international perspective. *Scandinavian Journal of Educational Research,* 33(4), 231-243.

Souder, W. E. (1993). The effectiveness of traditional vs. satellite delivery in three management of technology master's degree programs. *The American Journal of Distance Education, 7*(1), 37-53.

Thach, E. C. & Murphy, K. L. (1995). Competencies for Distance Education Professionals. *Educational Technology Research and Development*, 43(1), 57-79.

Totten, S., Sills, T., Digby, A., & Russ, P. (1991). *Cooperative learning: A guide to research*. New York: Garland.

von Glasersfeld, E. (1989). Constructivism in education. In A. Lewy (Ed.), *The international encyclopedia of curriculum* (pp. 31-32). Oxford, England: Pergamon Press.

Vygotsky, L. (1978). *Mind in society*. Cambridge, MA: Harvard University Press.

Zimmerman, B. J. & Martinez-Pons, M. (1988). Construct validation of a strategy model of student self-regulated learning. *Journal of Educational Psychology*, *80*, 284-290.

Zimmermen, B. J. & Paulsen, A. S. (1995). Self-monitoring during collegiate studying: An invaluable tool for academic self-regulation. In P. R. Pintrich (Ed.), *Understanding self-regulated learning* (pp. 13-28). San Francisco: Jossey Bass.

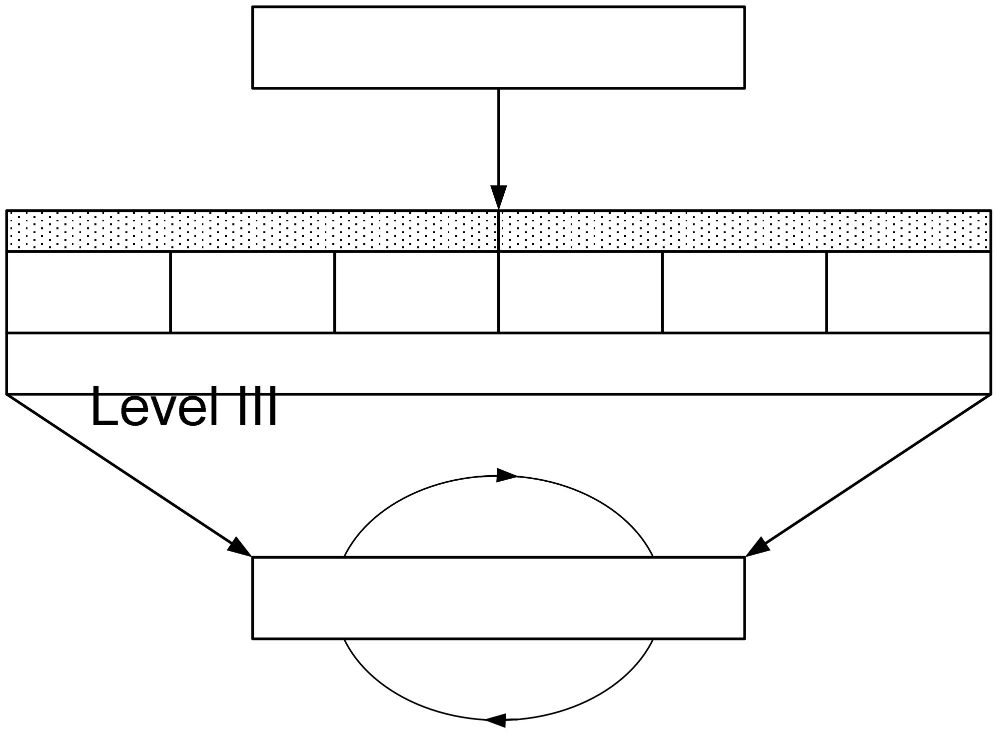


Figure 1. Three levels of planned e-learning interactions

## Learner-Centered Approaches

**Collaborative Problem-Solving**
(Nelson, 1992)

1. Build Readiness
2. Form and Norm Groups
3. Determine Preliminary Problem
4. Define and Assign Roles
5. Engage in Problem-Solving
6. Finalize Solution
7. Synthesize and Reflect
8. Assess Products and Processes
9. Provide Closure

**WebQuest**
(Dodge, 1998)

1. Introduction
2. Task
3. Process
4. Resources
5. Evaluation
6. Conclusion

**Eight Events of Student-Centered Learning**
(Hirumi, 2002c)

1. Set Learning Challenge
2. Negotiate Goals and Objectives
3. Negotiate Learning Strategy
4. Construct Knowledge
5. Negotiate Performance Criteria
6. Assess Learning
7. Provide Feedback (Steps 1-6)
8. Communicate Results

**BSCS 5E Model**
(Bybee, 2002)

1. Engage
2. Explore
3. Explain
4. Elaborate
5. Evaluate

**Case-Based Reasoning**
(Aamodt & Plaza, 1994)

1. Present New Case/Problem
2. Retrieve Similar Cases
3. Reuse Information
4. Revise Proposed Solution
5. Retain Useful Experiences

**Problem-Based Learning**
(Barrows, 1985)

1. Start New Class
2. Start a New Problem
3. Problem Follow-Up
4. Performance Presentation(s)
5. After Conclusion of Problem

## Experiential Approaches

**Experiential Learning**
(Pfeiffer & Jones, 1975)

1. Experience
2. Publish
3. Process
4. Internalize
5. Generalize
6. Apply

**Simulation Model**
(Joyce, Weil, & Showers, 1992)

1. Orientation
2. Participant Training
3. Simulation Operations
4. Participant Debriefing
5. Appraise and redesign the simulation

**Learning by Doing**
(Schank, Berman & Macpherson, 1999)

1. Define Goals
2. Set Mission
3. Present Cover Story
4. Establish Roles
5. Operate Scenarios
6. Provide Resources
7. Provide Feedback

## Teacher-Directed Approaches

**Nine Events of Instruction**
(Gagne, 1974, 1977)

1. Gain Attention
2. Inform Learner of Objective(s)
3. Stimulate Recall of Prior Knowledge
4. Present Stimulus Materials
5. Provide Learning Guidance
6. Elicit Performance
7. Provide Feedback
8. Assess Performance
9. Enhance Retention and Transfer

**Direct Instruction**
(Joyce, Weil, & Showers, 1992)

1. Orientation
2. Presentation
3. Structured Practice
4. Guided Practice
5. Independent Practice

**Elements of Lesson Design**
(Hunter, 1990)

1. Anticipatory Set
2. Objective and Purpose
3. Input
4. Modeling
5. Check for Understanding
6. Guided Practice
7. Independent Practice

Figure 2. Sample outlines of grounded instructional strategies

Step 1 – Select a Level III grounded instructional strategy based on specified objectives, learner characteristics, context and Level I epistemological beliefs;

Step 2 – Operationalize each event, embedding essential experiences and describing how the selected strategy will be applied during instruction;

Step 3 – Determine the type of Level II interaction(s) that will be used to facilitate each event; and

Step 4 – Select the telecommunication tool(s) (e.g., chat, email, bulletin board system) that will be used to facilitate each event based on the nature of the interaction.

Step 5 – Analyze materials to determine frequency and quality of planned e-learning interactions and revise as necessary.

Figure 3. Five step process for designing and sequencing e-learning interactions

Table 1. Sample instructional treatment plan based on WebQuest strategy

| Event | Description | Interaction(s) | Tools |
|---|---|---|---|
| Introduction | Present students with series of questions to establish context, need for learning and guide completion of proceeding task.<br><br>Ask learners to post message describing reports they have seen and/or written that work. | • Learner-Content<br><br>• Learner-Instructor<br>• Learner-Learner | • WWW<br><br>• BBS |
| Task | End products:<br>• feasibility report<br>• oral debriefing report | • Learner-Content | • WWW |
| Process | 1. Identify topic | • Learner-Content<br>• Learner Instructor | • WWW<br>• Email/BBS |
| | 2. Perform research | • Learner-Content<br>• Learner-Environment<br>• Learner-Other (Librarian) | • WWW<br>• Go to Library<br>• Online Library |
| | 3. Generate problem statement | • Learner-Content<br>• Learner-Learner<br>• Learner-Instructor | • WWW<br>• BBS/Stu. Pres.<br>• BBS/Mail/Stu. Pres. |
| | 4. Identify options | • Learner-Content | • WWW |
| | 5. Select criteria | • Learner-Content | • WWW |
| | 6. Write communication purpose | • Learner-Content<br>• Learner-Learner | • WWW<br>• BBS/Stu. Pres |
| | 7. Write report body | • Learner-Content | • WWW |
| | 8. Conduct peer reviews | • Learner-Content<br>• Learner-Learner | • BBS/Stu. Pres/Email |
| | 9. Write final report | • Learner-Content<br>• Learner-Instructor | • WWW<br>• Stu./email |
| | 10. Present debriefing | • Learner-Content<br>• Learner-Learner (Synchronous)<br>• Learner-Instructor | • WWW<br>• Audiobridge, Chat, Desktop Video/Audio Conferencing, |
| Resources | In addition to the information provided as links from each of the steps listed above, here are a series of resources that may help you complete your task.<br>• Engineering professors<br>• Galileo (online library)<br>• Engineering and scholarly journals<br>• Product Websites<br>• Textbook<br>• Handouts<br>• Sample reports | • Learner-Content<br>• Learner-Other (Professors)<br>• Learner-Environment (Textbook) | • WWW<br>• F2F, email, phone<br>• Purchase (F2f, or online) |
| Evaluation | *The following evaluation criteria will be used to evaluate your work and to determine completion of your task.*<br>• *Grading Rubric for Report*<br>• *Grading Rubric for Debriefing* | • Learner-Content<br>• Learner-Instructor | • WWW<br>• Email (feedback templates) |
| Conclusion | Learner to prepare and submit journal entry reflecting on experience. | • Learner-Content<br>• Learner-Instructor | • WWW<br>• Email |

Table 2. Planned interaction analysis of sample treatment plan

| Interaction | Quan. | Quality | Design Decision |
|---|---|---|---|
| Learner-Instructor | 8 | • Ask learner to post message<br>• Review and provide feedback on topic<br>• Review and provide feedback on problem statement<br>• Provide guidance on writing final report<br>• Provide guidance on preparing debriefing<br>• Assess and provide feedback on final report<br>• Assess and provide feedback on debriefing<br>• Review and provide feedback on journal entries. | Far too many interactions to manage. Need to review and revise by grouping two or more interactions, grouping students, eliminating or further automating interactions). |
| Learner-Learner | 5 | • Share short description of previously seen or written reports.<br>• Share and discuss problem statements.<br>• Share and discuss purpose statements<br>• Conduct peer reviews of reports<br>• Participate and share comments on debriefings | Maybe too much, need review and pay particular attention during testing |
| Learner-Other | 2 | • Contact Librarian<br>• Contact other Professors | Need to ensure Librarian prepared, need to ensure ready access to other professors. |
| Learner-Content | 21 | • 1 lesson overview page that provides description of and links to information about intro., task, process, resources, evaluation, and conclusion.<br>• Detailed descriptions of how to complete each of the 10 tasks associated with the process.<br>• Links to 7 resources<br>• 2 Detailed evaluation rubrics<br>• Description of how to prepare and submit journal entry. | Interface very important to test prior to official course delivery. |
| Learner-Environment | 3 | • Go to Library<br>• Acquire and read Textbook<br>• Acquire and read journal articles | Need to ensure ready access to library resource and textbook |
| Learner-Tool | 2 | • Assumed that learners will use word processor to prepare feasibility report.<br>• Assumed that learners will use PowerPoint to prepare presentation. | Need to ensure learners have access too and can utilize word processor and PowerPoint. |
| Learner-Interface | 34 | • All Learner-Instructor, Learner-Learner, and Learner Content interactions are mediated through computer interface. | Interface very important to test prior to official course delivery. |