

GUIDING DISTANCE EDUCATORS IN BUILDING WEB-BASED INSTRUCTIONS

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ABSTRACT

Nowadays, Web-based instructions have been widely applied in distance education. To create a successful Web-based learning environment, distance educators are interested in how to promote the quality of teaching. This article proposes guiding principles that are supported by Web-based theories and Moore's theory of distance education. Instructors or instructional designers need appropriate selection of instructional principles applied in Web-based environments. Moreover, instructional strategies, subject matter, and instructional technologies are other relevant variables for creating a high quality Web-based instruction for distance learners.

INTRODUCTION

The Internet becomes as communication links among computer-networked environments accessed by any user no matter where you are and when you want to. The Web provides user-friendly hyperlinks enabling one document to contain links to and from many others. Web browsers were developed that supported display of images, animation, videos, and hyperlinks. As a result, the advent of Web-based instructions, which relies upon the Internet, emphasizes the need for a clear understanding of how learners process and encode information presented in Web sites for instructional purposes. In order to prepare learners for success in the online learning, all distance educators have the motivation, knowledge and skills to use online environments for improving teaching at a distance.

Currently, a wide range of Web-based tools is available to distance educators (Huang, 2000). In the Web, information and resources from around the world can be accessed by anyone from anywhere in the world as long as a learner has a computer with an Internet connection. Search engines that are integrated with the Web can quickly and easily access information. As a result, distance learners

discover more useful information through Web search.

Web-based environment also provides both synchronous and asynchronous communication. For asynchronous interaction, learners access the conference at different times from each other via listservs, Bulletin Board Systems (BBS) or newsgroups. On the other hand, learners interact with others at the same time for synchronous communication environments, but they are not necessary at the same place such as chat rooms, online conferences or Multi User Dungeon (MUD). As a result, the Internet, providing a new opportunity for delivering instructions, has started a revolution in distance education.

Web-based systems support networks to access information. As Starr (1997) noted, a Web-based system went beyond static Web pages and page linking, by creating truly interactive networks with information exchange between users and servers. Additionally, Web-based systems provide a cross-platform environment. A cross-platform means Web systems that can be executed independently on various computer operating systems.

“Research that is not grounded in theory is wasteful” (Moore, 1991, p. 2). Only when the research is based on theoretical contexts, will researchers ask the important questions and link their questions to what other researchers have revealed (Moore, 1991). In developing more sophisticated and integrated research based on theory, a research study might develop greater predictive power and control over the general variables in the distance education environment (Moore & Kearsley, 1996). Our goal in this article is to provide a clear link among the theoretical principles of distance education, the practice of instructional design, and the practice of teaching.

THEORIES OF WEB-BASED ENVIRONMENTS

The concept of the Web-based learning environments is relevant from the perspectives of various learning theories.

Bruner’s three-form theory

As Bruner (1966) noted, there are three ways in which individuals represent the real world. Through action, icons and symbols, people can convert reality into their own unique portrayal of reality. First of all, action includes enactment and demonstration. The enactive form, the state of doing, is based on stimulus-response theory. Second, icons including images and pictures are a summary image or a mental picture of a path or pattern. Finally, the symbolic form consisting of language and numbers is an abstract form, since the word or number is a disconnection from the reality it represents. The three forms of representation are based on this argument: a theory of development must be connected to a theory of knowledge and to an effective theory of instruction (Presno, 1997).

Dual-coding theory

Dual coding theory emphasizes that two separate systems can work indepen-

dently or together for verbal and imagery processing (Butler & Mautz, 1996). This theory consists of verbal and imagery subsystems. The verbal subsystem specializes in presenting and processing language-based events and information. On the other hand, the imagery subsystem includes images for shapes, sounds, actions, emotional responses and other nonverbal objects and events.

Theory of multiple representations

The use of multiple representations in instruction are recommended by philosophers, media researchers and instructional designers (Tergan, 1997). Processing multiple representations of a subject matter content is expected to be effective in supporting the construction of respective mental representations. The flexibility of Web-based environments represent subject matter knowledge in such a way that it may be easily accessed by users or presented to learners from different views. Thus, Web-based environments applying multiple representations are to enhance the construction of task-adequate mental representations of knowledge and to facilitate the transfer of knowledge to realistic problem situation.

Cognitive flexibility theory

Cognitive flexibility theory emphasizes the real world complexity and ill-structuredness of many knowledge domains (Spiro et al., 1995). From an ill-structured aspect of knowledge, advancing knowledge acquisition, such as attaining an understanding of important elements of conceptual complexity, the ability to use acquired concepts for reasoning and inference, and the ability to flexibly apply conceptual knowledge to novel situations, can be facilitated by the principles of this theory.

Gagne's conditions of learning

Gagne (1985) proposed a descriptive theory of knowledge consisting of five outcome categories: intellectual skills, verbal information, cognitive strategies, motor skills, and attitudes. Intellectual skills are “knowing how” to categorize and use materials. Verbal information can be described as “knowing what”. Cognitive strategies can be called “learning strategies” or “learning skills”. Motor skills are the ability to coordinate movement that including simple muscle movements and complex movement. And attitudes, such as feelings and emotions, can be produced through positive and negative experience (Gagne, Briggs, & Wager, 1988). Thus, Gagne’s theory is a systematic instruction and learning process.

Merrill's instructional transaction theory

Instructional transaction theory (Merrill & the ID₂ research group, 1996) proposed a set of instructional rules for selecting and sequencing knowledge objects. It also consists of a sequence of messages to knowledge objects which causes them to display multimedia resources representing the knowledge object,

display their name or description, change their location or property values, and consequently the multimedia resources associated with these changes property values. Moreover, instructional transaction theory identifies several classes that include identification execution, explanation, judging, classification, generalization, and transfer. Based on these instructional transactions, learners may be stimulated effectively by the processes of transactions.

Elaboration theory

Based on cognitive psychology, acquisition and retention of new knowledge are highly dependent on the cognitive structure of the learner (Hoffman, 1997). In general, elaboration theory is a strategy of instructional design that focuses on the organization and sequencing of subject-matter content by addressing four design problem areas: selection, sequencing, synthesizing, and summarizing (Reigeluth & Stein, 1983). From Reigeluth's and Darwazeh's (1982) viewpoint, new knowledge and ideas should be taught from simplified form to more detailed and complex gradually.

MOORE'S THEORY OF TRANSACTIONAL DISTANCE

Moore's theory (Moore, 1990, 1991, 1994; Moore & Kearsley, 1996) has widely been discussed and applied in distance education (Hillman, Willis & Gunawardena, 1994; Simonson, Schlosser & Hanson, 1999). Moore (1991) identified three dimensions as interaction, course structure, and learner autonomy affecting the teaching procedures in distance learning.

Interaction

First, interaction refers that the instructor gives instruction and the learner responds. There are different types and levels of interaction that is within a text, a study guide, or an audio as well as highly interactive media of telecommunications. First, learner-to-instructor interaction is highly desirable by many distance learners. In this interaction, instructors provide motivation, feedback, and support by interaction between the instructor and learners. Secondly, learner-to-content interaction is the process of obtaining intellectual information and has the result of learners' understanding in the course content. Finally, learner-to-learner interaction is the exchange of information, ideas and interaction that occurs between learners with or without the presence of an instructor.

Course Structure

Course structure refers to a measure of an education program's responsiveness to learners' individual needs (Moore, 1990). Structure could be defined as the rigidity or flexibility of the programs' educational objectives, teaching strategies, and evaluation methods, so that distance courses can accommodate or meet learner's individual needs. Moore and Kearsley (1996) noted that a course includes such elements as learning objectives, content themes, information pre-

sentations, case studies, exercises, projects, and tests. Instructors may be provided detailed grading schemes to ensure the learners are able to achieve the criteria. Moore (1991) also proposed that evaluation should focus on affective reactions to the delivery of content, the media used, and the overall quality of the instruction materials.

Learner Autonomy

Learner autonomy is the extent to which the “learner determines objectives, implementation procedures and resources and evaluation in a program” (Moore, 1990, p. 13). Moore (1991) declared that if models of distance education only considered teaching factors they would be flawed. It is necessary to consider the idea of learners being autonomous individuals constructing their own knowledge based on their own experience. The concept of learners chooses their own learning objectives and behaviors to construct and control much of the learning process. As a result, learners have different capacities for making decisions about their own learning. Further, “learner autonomy should be a goal of distance education” (Moore, 1994, p. 2).

INSTRUCTIONAL PRINCIPLES FOR WEB-BASED DESIGNERS

The Web-based theories and Moore’s theory can guide the practice of teaching and the design of Web-based learning environments. For distance educators, the instructional principles deriving from these theories are as follows:

1 Assess the necessary prerequisite skills.

When a distance course is delivered via a Web-based environment, the learners need to have enough technological proficiency in the prerequisite skills and a strong motivation to learn by technology (Wagner, 1993). If the learner is not skilled in interacting with the delivery system, the learner has to learn not only the course content, but also the technology. That is, before the learner can successfully interact with the instructor, content, or other learners, learners need to operate proficiently the instructional media (Hillman et al., 1994). In addition, communication media should provide numerous sensory stimuli, which promote the active exchange of information among teachers, learners, and the content of course (Wagner, 1993). Hillman et al. (1994) claimed “interaction occurs when a learner must use intervening technologies to communicate with the content, negotiate meaning and validate knowledge with the instructor and other learners” (p. 30-31). Therefore, technological proficiencies and prerequisite skills were the crucial factor to help learners’ success with online learning (Wagner, 1993). As a result, access learner’s computer skills before they enter an online program are necessary for their future success.

2 Increase technical supports available to distance learners.

Focus on determining if learners possess the technological skills to enjoy a

Web-based learning program that matches individual learning circumstances, since the prerequisite skills contribute to learners' confidence and persistence in learning at a distance. Successful individual learning at a distance is highly dependent on how comfortable the learner feels in working with the delivery system. When the learner cannot get support to learn the technology as often as the learner needs, the resulting frustration can reduce the learner's autonomy to learn the subject matter. Moreover, the frustration with technology will also affect self-directed learning in distance courses or even the distance program itself. Therefore, an increase in the technical support systems available to online learners is necessary for students learning at a distance.

3 Interactions through advanced technologies are necessary.

Since individual learning at a distance is a salient characteristic of distance education, the physical separation between the instructor and learners or a learner and other learners always exists.

Passing on knowledge and skill involves interaction with others. At least, it involves a "teacher" and a learner. Or, if the teacher is not a human, it could be such a vicarious tool as a book, or film, or an interactive computer. (Bruner, 1996, p. 20)

Some studies found that distance learners did not enjoy their classroom experience, did not interact as much with other learners or the instructor, or did not feel as comfortable with the physical separation between the instructor and learners. In Gagne's conditions of learning, learning activities are the two-way transaction between learners and instructors, learners and learners, and learners and course contents to stimulate learning capacity. Moreover, Merrill's instructional transaction theory indicates that interaction is a crucial factor that

can assist individuals to promote learning effectively with a given configuration of abilities and aptitudes. Thus, two-way communication may help learners to create their own knowledge through the learner's individual background.

4 Provide qualify discussion questions.

A Web-based program should provide a series of qualifying questions or statements that enable the learners to match the objectives of the courses. In this case, the learners should learn how to search and know which search engines best for which kind of inquiry. Web searches are conducted with such Web browsers as Netscape or Internet Explorer through hybrids like Infoseek, Alta Vista and Excite combine subject directories and search engines to help learners locate relevant Web sites. Search engines opened the door to retrieval rich information anywhere on the Internet in the world. By sharing the experiences, the learners will be amazed at what others have been able to find on the same topics you are interested in. As a result, asynchronous and synchronous communication serves the role of a thinking device for the collaborative construction of knowledge and enhances learners' creative abilities.

5 Arrange appropriate size of discussion groups.

Advanced technologies provide instructors the ability to communicate with groups, as well as with individuals, and to link individual learners into virtual learning groups. The existence and size of a learning group was one of the important environmental factors affecting interaction. Since instructors take much time to interact with learners through electronic communications and receiving feedback is important for their learning, Owston (1997) suggested that 15 to 20 learners to a learning group in an online learning situation are manageable.

6 Enhance learners' higher order thinking skills.

In Web-based learning, interaction is not just to select simple menus or to click objects on the screen. Learners in Web-based environments could interact with each other, with instructors, and on-line resources by Internet tools, hyperlinks, browsers, and authoring programs (Khan, 1997). When individuals are learning new knowledge, they must understand relationships of all relevant contents. Since learners control the pacing of interaction, asynchronous communication provides learners more time to reflect on their own ideas and encourage them to do more critical thinking. As a result, the interaction should involve complex activities by the learners, such as engaging and reflecting, annotating, questioning, answering, pacing, elaborating, discussing, inquiring, problem solving, linking, constructing, analyzing, evaluating, and synthesizing (Berge, 1999).

7 Offer hypermedia well-programmed instructions.

Web-based systems offer a multimedia environment. The information in the Web-based systems can be simultaneously represented in any combination of media format, such as text, image, graphic, sound, voice, and animation. Bruner (1966) suggested instructions must specify the structured ways to represent knowledge so that it can be easily grasped by the learner. Good methods for structuring knowledge should result in simplifying, generating new propositions, and increasing the manipulation of information. In addition, hypertext and hyperlinks are too complex unless the three forms of representation are used in instruction (Bruner, 1996). Thus, a multi-media program seems to be more effective than a single medium program (Perraton, 1988). In addition, the hypermedia tool can create an integrating environment that combines enactment, icons, and symbols based on three-form theory. Moreover, the dual-coding theory provides a practical explanation of why many think that hypermedia-based instruction will be so effective for learning. Up to this point, well programmed instructions, such as drill and practice, tutorial and self-assessment software, provide distance learners a lot of opportunities to practice the learning contents by themselves.

8 Provide ill-structured learning environments.

Instructions can be represented in the Web-based courses by means of nodes

and links. Nodes in hypertext systems generally contain verbal information, graphics, charts, and pictures. Moreover, links, electronic connections between nodes, may contain sound, animation, simulation, and video (Tergan, 1997). Ill-structured aspects of knowledge are often presented in real-world and advanced knowledge acquisition (Spiro et al., 1995). Since one of main characteristics of hypermedia is random access, there is a tendency in Web-based instructions toward ill-structured presentation of course content (Spiro et al., 1995) The Web can be a loose term for presentations containing more complex arrangements than the traditional linear text and is already widely acknowledged to be a promising teaching and learning tool.

New technical support systems like the Internet or WWW are widely applied and the structure of knowledge has changed from linear into nonlinear or from static into dynamic (Spiro et al., 1995). This nonlinear and random-access network offer a new direction rather than the conventional step-by-step concept. The multi-linkages within, between, and among the nodes as a network permit the nonlinear organization and reorganization of the nodes and allow for multiple dimensional navigations through a body of data. Thus, cognitive flexibility theory has the characteristics of random access, nonlinear exploration, and multiple representations (Maddux et al., 1997). The use of multiple representations of subject matter content, indicating different conceptual views, contexts of relevance, and formats of representation, is central for engaging the learner actively in the knowledge construction process (Tergan, 1997).

9 Course structure meet individuals' needs.

In Web-based environments, individual users can decide their own routes of inquiry and access linear and nonlinear information. The Web offers access to various types of presentation that provide the opportunity for discussion on a structure environment, and links to other online resources. Khan (1997) stated that a Web-based learning course could be designed to address all students' learning styles by incorporating a variety of multimedia. Thus, Web pages have become one of the most popular represented forms in courses for distance learning through the Internet. Courses are structured in many ways to meet the needs to produce, copy, deliver, and control mediated messages. When putting curriculum into hypermedia, educators can create a learning environment for learners to do and create their own knowledge. Thus, learning and teaching structures should be adapted in order to meet the students' needs. When a learner processes information through both verbal and imagery, these multi-model approaches to education are thought to be particularly effective for accommodating learners with diverse styles and preferences for learning.

10 Let learners control their learning process.

Subject matter content is fragmented in single and autonomous information units which can be read and interpreted independently. Since Web-based instructions can integrate multiple representations of a subject matter and present infor-

mation in different formats such as a hierarchical or a linear structure, the use of different symbol systems and multimedia learning may be facilitated. Web-based environments offer the learner free access to all information units represented in the hypertext or hypermedia base by means of two information retrieval modes, browsing and searching. In general, Web users have full control over their own learning situations and this high level of interaction gives users dynamic control of information.

11 Encourage distance learners to actively participate group discussions.

Since distance learning need not be the individual, lonely learning environment it used to be because of innovations of educational technology. HyperMedia learning instruction offers interactive communication and creates a potentially collaborative learning environment. Learners can engage in online discussions, debates, or negotiations. In addition, this simultaneously synchronous and asynchronous nature provides a productive environment for group problem-solving activities for the generation and testing of new ideas. Active participation is one of instructional strategies used to promote interaction among instructors, learners and contents (Wagner, 1993). However, not all distance learners are to actively engage in discussions. It is still important to develop and to engage interdependence among individuals in learning groups (Moore, 1994). Therefore, distance educators should assist and encourage them to actively participate in discussion groups.

12 Facilitate students' learning.

In contrast to traditional learners, distance learners move from passive receivers to control their learning. In Web-based learning environments, the Internet provides only information. As a matter of fact, some learning takes place beyond the instructor's scope, for example, in discussions with peer learners. Thus, distance educators still have a responsibility to monitor and warrant the quality of learning and peer discussions. In addition, distance educators should take into account learners' abilities that could include developing a personal learning plan in some ways different from that of other learners, finding resources for study, or deciding whether progress is for himself or herself. The distance program should combine and mix media to teach in the best way know and preserve and increase opportunities for adaptation to individual differences. It is still necessary for the instructor to build in sufficient support, directions and guidelines for online learners. As a result, the distance instructor should be a consultant, guide, and resource provider.

The summary of instructional guidelines for distance educators was included in Appendix A.

CONCLUSIONS

This article has identified a design of guiding principles embedded within distance education. Since the distance and the special environment of teaching and learning affect instructor's and learner's behaviors in major ways, there is a need to use some special techniques that lead to success. The instructor or instructional designer needs to select appropriate technology media and educational pedagogy based on instructional strategy, subject matter, and instructional theory to nurture distance learners' cognitive development. As Chen (1997) noted, "Sound distance education is the result of effective communication and instruction and adherence to coherent instructional principles" (p. 34). Distance educators need and want assistance in their efforts to integrate information technology into their instructions. If a high quality Web-based instruction is provided, it will benefit distance learners, educators, and the society at large.

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REFERENCES

- Berge, Z. L. (1999). Interaction in post-secondary Web-based learning. *Educational Technology*, 39(1), 5-11.
- Butler, J.B., & Mautz Jr., R.D. (1996). Multimedia presentations and learning: a laboratory experiment. *Issue in Accounting Education*, 11(2), 259-280.
- Bruner, J. S. (1966). *Toward a theory of instruction*. Cambridge: Harvard University Press.
- Bruner, J. S. (1996). *The culture of education*. Cambridge: Harvard University Press.
- Chen, L.-L. (1997, July/August). Distance delivery systems in terms of pedagogical considerations: A reevaluation. *Educational Technology*, 34-37.
- Gagne, R.M. (1985). *The Conditions of learning and theory of instruction* (4th ed.). New York: Holt, Rinehart, and Winston.
- Gagne, R. M., Briggs, L. J., & Wager, W. W. (1988). *Principles of instruction design* (3rd ed.). New York: Holt, Rinehart, and Winston.
- Hillman, D. C. A., 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.
- Hoffman, S. (1997). Elaboration theory and hypermedia: Is there a link. *Educational Technology*, 37(1), 57-64.
- Huang, H. M. (2000). Instructional technologies facilitating online courses. *Educational Technology*, 40(4), 41-46.
- Khan, B. H. (1997). *Web-based instruction*. Englewood Cliffs, NJ: Educational Technology Publications.
- Merrill, M. D., & ID₂ research group (1996). Instructional transaction theory: instructional design based on knowledge objects. *Educational Technology*, 3(3), 30-37.
- Maddux, C. D., Johnson, D. L., & Willis, J. W. (1997). *Educational computing, learning with tomorrow's technologies* (2nd ed.). Needham Height, MA: Allyn & Bacon
- Moore, M. G. (1990). Recent contributions to the theory of distance education. *Open Learning*, 5(3), 10-15.
- Moore, M. G. (1991). Editorial: Distance education theory. *The American Journal of Distance Education*, 5(3), 1-6.
- Moore, M. G. (1994). Editorial: Autonomy and interdependence. *The American Journal of Distance Education*, 8(2), 1-5.
- Moore, M. G., & Kearsley, G. (1996). *Distance Education: A system view*. Belmont, CA: Wadsworth.
- Owston, R D. (1997). The World Wide Web: A technology to enhance teaching and learning? *Educational Researcher*, 26(2), 27-33.
- Perraton, H. (1988). A theory for distance education. In D. Sewart, D. Keegan, & B. Holmberg (Eds.), *Distance education: International perspectives* (pp. 34-45). New York: Routledge.

- Presno, C. (1997). Bruner's three forms representation revisited: action, pictures and words for effective computer instruction. *Journal of Instructional Psychology*, 24(2), 112-118.
- Reigeluth, C. M., & Darwazech, A. (1982). The elaboration theory's procedure for designing instruction - A conceptual approach. *Journal of Instructional Development*, 5(3), 22-32.
- Reigeluth, C. M., & Stein, F. S. (1983). The elaboration theory of instruction. In C. M. Reigeluth (Ed.), *Instructional Design Theories and Models: An Overview of Their Current Status* (pp. 335-381). Hillsdale, NJ: Lawrence Erlbaum Association.
- Simonson, M., Schlosser, C., & Hanson, D. (1999). Theory and distance education: A new discussion. *The American Journal of Distance Education*, 13(1), 60-75.
- Spiro, R. J., Feltovich, P. J., Jacobson, M. J., & Coulson, R. L. (1995). Cognitive flexibility, constructivism, and hypertext: Random access instruction for advanced knowledge acquisition in ill-structured domains. In L. P. Steffe, & J. Gale (Eds.), *Constructivism in Education* (pp. 85-107). New Jersey: Lawrence Erlbaum Associates.
- Starr, R. M. (1997, May/June). Delivering Instruction on the World Wide Web: Overview and basic design principles. *Educational Technology*, 7-15.
- Tergan, S. O. (1997). Multiple views, context, and symbol systems in learning with hypertext/hypermedia: a critical review of research. *Educational Technology*, 37(4), 5-17.
- Wagner, E. D. (1993). Variables affecting distance educational program success. *Educational Technology*, 33(4), 28-32.

APPENDIX A

Instructional principles based on Web-based theories and distance education theory

