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Using Instructional Theory to Facilitate Communication in Web-based Courses

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ABSTRACT

This articles examines the role of computer-mediated communication as well as broader interpretations of communication in Web-based instruction. Overviews of cognitive processing and cognitive constructivist paradigms are presented to illustrate their relevance for guiding development of Web-based courses. Instructional goals and communication strategies associated with these paradigms are identified. We conclude that developers should use instructional theories to guide choices for facilitating communications goals in Web-based courses. Because of increasing demands on professionals in many disciplines to develop Web-based instruction, it is recommended that university training programs require appropriate candidates to demonstrate relevant theoretical knowledge and skill competencies.

Keywords

Web-based instruction, Internet communication, instructional theory, cognitive processing, cognitive constructivist

Introduction

Web-based instruction is a rapidly growing instructional format that is challenging the traditional learning model in higher education. Many institutions of higher education are on the bandwagon, or are running furiously to jump on (Brahler, Peterson, & Johnson, 1999). The widespread availability and access to the Internet, a student population that is increasingly non-traditional, and occupational forces that require worker re-education, have fueled the avalanche of Web-based courses in higher education. One company has indexed over 3,700 such courses and 57 degree programs at over 100 accredited institutions on their Web site (http://www.caso.com).

For purposes of this paper, Web-based instruction is defined as instruction via the World Wide Web that features hyperlinking (described in Carliner, 1999) as well as communication capabilities. Computer technologies used to develop and deliver Web-based instruction vary depending on factors such as learning goals, pedagogical approach, and instructor expertise or access to expertise in using these technologies. Courses that include presentation of content and structured learner interactivity are typically developed using Web authoring software, programming language, multi-media (Carliner, 1999), and communication tools such a e-mail and bulletin boards. The range and sophistication of content presentation via Web courseware varies from "the provision of lecture notes and lecture support material through to integrated and interactive tutorial packages" (Marhsall & Hurley, 1996, p. 5), although advanced learning environments are not supported (Schneider, D., 1994). Other Internet-based courses rely predominantly on communication tools (i.e., bulletin boards, chat, e-mail) that provide learners with opportunities to engage in reflective dialog (Kuehn, 1994).

Communication in Web-based Courses

There are two interrelated forms of communication in Web-based learning environments: instructor-learner communication and learner-content communication. Instructor-learner interactions include those between the instructor and groups of learners (i.e., one-to-many), the instructor and individual students (i.e., one-to-one), or

among students (i.e., many-to-many). These communication configurations reflect those found in a typical classroom. These same configurations are possible using computer technologies such as conferencing, e-mail, and other collaborative support tools as communication vehicles for connecting participants (Kuehn, 1994).

The second, but less obvious, form of Web-based communication is that which occurs between the learner and content. There are two general ways in which the learner can engage in the subject matter: the learner can attempt to accurately acquire knowledge presented via Web presentations or s/he can construct personal meaning by engaging in dialog and reflection. These two types of learner-content interactions reflect two cognitive paradigms: cognitive processing and cognitive constructivism. These paradigms are based on different assumptions about the nature of knowledge and how individuals learn about their world. They result in different instructional approaches (e.g., ID2; Cognitive Flexibility Theory) and different types of communications. This paper will address the influence of these two paradigms on communication practices in Web-based courses.

Instructor - Learner Communication

Computer-mediated communication involves using computer communication technologies such as bulletin boards and e-mail to connect learners at a distance. Interactions commonly occur asynchronously, with participants responding at different times, although synchronous interactions are possible (Kuehn, 1994; Jonassen, Davidson, Collins, Campbell, & Haag, 1995; Pincas, 1998; Warschauer, 1997). Such communications can supplement or be the primary mode of course delivery.

The major characteristics of computer-mediated communication are time and place independence, interactions among various combinations of individuals, and an absence of communication cues found in face-to-face interactions (Harasim in Althaus, 1997). Warschauer (1997) included Web hyperlinking as a feature of computer-mediated communication. Learners can use the Web hypertext environment to access information that they can use in collaborative discussions. Jonassen et al. (1995) included Web-based databases and news groups as aspects of computer-mediated communication.

There is a proliferation of communication technologies that can be used in Web-based courses. Examples of synchronous and asynchronous communication tools that are currently and readily available to most instructors are e-mail, bulletin boards, chat, instant messaging, voice messaging, and listservs. In addition, video and audio conferencing, shared editors, and imaging programs are available to support synchronous communications (Carliner, 1999). Collaborations conceptualized as "communities of learners" are supported by communication tools ranging from decision support systems to computer-supported intentional learning environments (CSILEs) that permit learners to build knowledge databases (Jonassen, et al., 1995; Schneider, 1994; Wagner, 1997).

Decisions regarding the form and configuration of interactions include whether interactions should occur synchronously or asynchronously, and between/among which participants (i. e., instructor to student, students to students). Technology is available to support just about any decision an instructor makes regarding communication. Given these circumstances, questions arise as to what criteria should be used to make such decisions. On a practical note, decisions are likely to be guided by the availability and ease of access of certain communication tools (i.e., e-mail, bulletin boards), by the instructor's level of expertise and understanding of communication technologies, and by the instructor's willingness to experiment with new and more complex communication tools.

Another important criterion for selecting communication tools is the instructional purpose of the communication. Interactions should be thought of in terms of the larger instructional experience. As Wagner (1997) advised , "*The best rule of thumb for effectively designing an interactive learning experience … is to first consider the goals and objectives of a specific learning experience. From this perspective, it is both far more appropriate and effective to begin the process of selecting the strategies and tactics needed to achieve the desired ends of the learning experience, for the specific audience at hand, given the specific conditions likely to be encountered in a given setting. In this way, interaction can serve as an outcome of clearly conceptualized, well-designed, and well-developed instruction and training "* (p. 25).

From this perspective, communication is transformed from an isolated instructional activity to an integrated element of a larger instructional framework. In considering learner outcomes, as Wagner noted, emphasis is shifted from *who* is communicating to the desired *outcome* of the communication. Wagner chronicled 12 such outcomes that she deemed important in light of current technological advances: communication for increased participation, communication, feedback, enhanced elaboration and retention, support of learner control and self-

regulation, motivation, negotiation of understanding, team building, discovery, exploration, clarification of understanding, and closure.

In calling for communication to become an integrated component of "well-designed and well-developed instruction", Wagner has provided a useful perspective on the role of communication in distance learning. However, her recommendations do not address how communication strategies should be implemented in Web-based courses. The answer depends upon how the instructor thinks that learning and teaching occur … in other words, the theoretical orientation of the instructor. Selection of a particular interaction (i.e., instructor to student or students to students) and communication method (i.e., e-mail, conferencing) should be based on the instructional purpose, that in turn, is guided by a pedagogical rationale.

The potential for increased opportunities for collaboration among learners has connected computer-mediated communication to a constructivist pedagogy (e.g., Jonassen, et al., 1995). Much of the research in this area has examined variables associated with constructivist strategies (e.g. equality, collaboration, construction of knowledge, and learner control), although not all researchers make explicit the theoretical connection. Although equivocal, findings suggest that computer-mediated communication either (a) fosters greater participation among learners, transcending barriers (i.e., based on status, gender) that occur in typical classroom setting, or (b) results in improved decision-making and higher-level reasoning (see discussions in Althaus, 1997; Kuehn, 1994; Olaniran, Savage, & Sorenson, 1996).

The constructivist community has seized the opportunity to use Internet technology to develop "communities of learners" (e.g., Jonassen, et al., 1995). As noted by Ravitz (1997, p.2), for many the "Internet has helped to bring about a shift from an "instructional" model to an information-age "conversation" model of learning…" that fosters constructivist learning goals. The influence of this paradigm shift on instructor-learner communication in Internet learning environments will be explored further in the following sections.

Content-Learner Communication

In Web-based courses, as in any learning environment, instructional interactions include "interactions that take place between learners and the content they are trying to master" (Moore, in Wagner, 1997, p. 21). Instructional strategies used to sequence the delivery of course content as well as the strategies used to present (i.e., "teach") content are communication tools that determine the manner in which the student interacts with the content. The pedagogical design "communicates" information that shapes students' experiences, including expectations about the purpose of learning, depth of reflection and understanding, level of participation, degree of learner control, and perceptions of the instructor's role. Pedagogical communications can be overt, as in a direct statement of course objectives, or covert, as in organization and presentation strategies.

Communication in Web-based instruction involves more than interactions between the instructor and learners via communication methods such as conferencing, instant messaging, and e-mail. Communication occurs through instructional design features that shape the learner's interaction with content. This definition of Web-based communication highlights the connection between pedagogy and communication. Two epistemological perspectives (cognitive processing and cognitive constructivism), that support differing instructional theories and communication practices are discussed in the following sections.

Epistemology, Pedagogy and Web-based Learning

Cognitive Processing

Theory

The cognitive revolution in the 1970s emerged from different theoretical perspectives and gave rise to different theories of learning and instruction. One of these perspectives, cognitive processing, focused on processing and representation of knowledge (i.e., information processing, symbolic reasoning) (Dole & Sinatra, 1998; Gallagher, J. P. 1979: Jonassen, et al., 1995; Reynolds, Sinatra, & Jetton, 1996). A second, approach, cognitive constructivism, focused on processes of knowledge construction (Cronin, 1997; Jonassen, et al., 1995).

The cognitive processing paradigm dominated the field of cognitive psychology until the 1990s (Wilson, 1999). It is based on the objectivist paradigm, which purports that knowledge (i.e., reality) exists independent of and

external to the learner. Knowledge is a fixed commodity and, as such, can be measured and known objectively. If knowledge exists "outside" the learner, it is the job of the learner to acquire and retain an accurate representation. It is the job of the instructor to reflect or "mirror" reality (Jonassen, et al., p. 10).

The rise of cognitive psychology refocused attention on internal, mental processes (Reynolds, Sinatra, & Jetton, 1996) and was welcomed as an opposition force to the behavioral paradigm that dominated the time. However, the welcome was short-lived as differences in subject matter (i.e., mental processes versus observable behavior) failed to overshadow epistemological similarities. The assumptions of empiricism, reductionism, and mechanism that grounded behavioral theory within the objectivist paradigm, to a larger degree, held true for cognitive processing theories. These same assumptions are evident in the focus on mental structures and processes that define cognitive processing theories (Reynolds, Sinatra, & Jetton, 1996; Wilson, 1999). Cognitive processing theorists share, if not the same epistemological bed, at least the same house with behaviorists. The true "opposite" to the objectivist epistemology of cognitive processing is constructivism (Heylighen, 1997).

According to objectivist epistemology, knowledge has an objective and separate existence whose attributes, relationships, and structure can be known (Cronin, 1997). As a knowledge expert, the instructor (and/or appropriately designed content in the case of Web-based instruction) embodies an accurate representation of this structure. Teaching involves presenting knowledge and modeling its structure in such a way that it can be accurately acquired and reproduced (Cronin, 1997; Jonassen, et al, 1995). Learning involves the accurate acquisition and replication of this external knowledge (Cronin, 1997; Jonassen, et al., 1995). The instructor is the transmitter of knowledge and the learner is a receiver (Jonassen, et al., 1995).

The theoretical constructs of cognitive processing theories are mental structures and processes. In this paradigm, learning is described in terms of mental mechanisms and operational processes such as short-term memory, long-term memory, encoding, and retrieval (Anderson, Reder, & Simon, 1995). The key emphasis is on describing units of knowledge representation such as propositional networks and schema (Gallagher, 1979). Instructional theories (e.g., ID2) based on the cognitive processing paradigm use prescriptive strategies to promote accurate knowledge acquisition by the learner. Sensory memory highlights the role of attention in the learning process and suggests instructional strategies such as (a) psychophysical variation (i.e., change in color, size, pitch); (b) discrepant activities (i.e., using novelty, complexity, or ambiguity), or; (c) use of emotional-eliciting stimuli (i.e., choice of words, images). Models of long-term memory suggest instructional strategies such as (a) activation of prior knowledge, (b) presenting information within a meaningful context, and (c) hierarchical sequencing and organization that elaborates and connects new with existing knowledge (see Hoffman, 1999, Encyclopedia of Educational Technology for other examples).

The key to implementing these prescriptive strategies lies in the analogy between mental structures and processes and the associative structure and hyperlinking processes of the Web. The challenge is to construct an instructional environment so that it accurately reflects the expert's (i.e., instructor's) knowledge structure. The nature of the Web can more accurately model this structure, but the limitless hyperlinking environment can detour the learner from adhering to prescribed learning activities. Thus, instructional decisions regarding organization, degree of user control of navigation, and level of interactivity are critical in the development of Web based courses if a faithful communication of the expert's knowledge is to be achieved.

The fundamental instructional goal of this epistemological paradigm is accurate transmission and reception of knowledge. Just as this tenet drives strategies that determine the communication between learner and content, it also drives communication between the instructor and learners, and among learners. Communication is a means (i.e., strategy) to an end (i.e., acquisition of knowledge). This purpose serves as a guide for decisions about the mode (i.e., synchronous, asynchronous), technology (e-mail, bulletin board, video conferencing), and configuration of interactions (i.e., instructor to students, students to students) that are part of the course design. It suggests that the primary communication mode will be that from instructor to students or to groups of students.

The instructor's role in developing Web-based instruction under the cognitive processing paradigm is to use prescriptive theories and strategies to transmit knowledge. In making instructional decisions the instructor considers the structure of knowledge, the learner's internal cognitive processing structure (i.e., how information is symbolically represented and processed), and the learning goal. Application of prescriptive strategies determines the nature of the communication between the learner and content.

Instructional Goals and Communication Strategies

There are four primary instructional goals of Web-based instruction based on a cognitive processing approach. For each goal, communication strategies must be identified and implemented to maximize goal attainment. Examples of communication strategies are listed below, but this list is not exhaustive. In selecting strategies, instructors must consider both the type of communication (i.e., one-to-one, many-to-many) and time elements (i.e., synchronous vs. asynchronous) as they relate to the basic purpose of education (i.e., transmission of expert knowledge).

Instructional Goal #1: Present course content in a manner that hierarchically structures the sequence of information.
Communication strategies include (a) using an authoring program to control the structure and sequencing of course content (one-to-many, asynchronous), (b) embedding questions in course materials to facilitate elaboration of content (one-to-many, asynchronous), and (c) using audio and video conferencing to present content and prescribe learning activities (one-to-many, synchronous).

Instructional Goal #2: Obtain student feedback to insure accuracy of understanding. Communication strategies include (a) using e-mail to pose questions and solicit answers (one-to-one, asynchronous), (b) creating a bulletin board to pose topics for discussion and to solicit responses that reflect students' thinking about the subject matter (many-to-many, asynchronous), and (c) using audio and video conferencing to discuss content and solicit student responses (one-to-many, synchronous).

Instructional Goal #3: Provide opportunities for students to question the instructor in order to insure accuracy of understanding. Communication strategies include (a) providing hyperlinks to the instructor's e-mail address (one-to-one, asynchronous), (b) using instant messaging (one-to-one, synchronous), and (c) creating a bulletin board to promote questioning and provide instructor responses that are accessible to all students (one-to-many, asynchronous).

Instructional Goal #4: Create opportunities for students to communicate with each other in order to share their understanding of course content. Communication strategies include (a) establishing chat rooms that enable on-line discussions of course content (many-to-many, synchronous) and (b) creating a bulletin board for this same purpose (many-to-many, asynchronous).

Cognitive Constructivism

Theory

The constructivist paradigm reflects a position that knowledge is not independent of the learner but is internally constructed by the learner as a way of making meaning of experiences (Cronin, 1997; Jonassen, et al., 1995). This position is actually a collection of different perspectives ranging from a purist view that knowledge is solely an internal and subjectively constructed phenomenon to a view that acknowledges an objective reality, but one that can only be known subjectively (also see Wilson, Teslow, Osman-Jouchoux, 1995). Learning involves making meaning of experiences and thus the knowledge constructed by each learner is unique (Jonassen, et al., 1995).

One mechanism that avoids the absurdity of a totally relativistic (and thus nonsensical) view of reality is the process of consensus. Consensus can be internal to the learner (i.e., consistency of knowledge) or external via social negotiation with others (Heylighen, 1997). Heylighen identified the additional mechanisms of subjective coherence, intersubjective consensus, and (indirect) comparison with "objective" environment. Certainly, internal coherence and social agreement are criteria that are important to the instructional process. Building consensus either internally or with others requires "a discipline of argument with opposing points of view" (Cronin, 1997 p.2). This mandates a learning environment that provides opportunities for dialog to occur.

Constructivist instruction is not the process of carefully arranged prescriptive strategies, but of coming to understand how people make meaning, and then to create learning environments that promote this construction (Jonassen, et al., 1995). Examples of instructional theories and models that highlight different aspects of the constructivist perspective are Cognitive Flexibility Theory (Spiro, Feltovich, Jacobson, & Coulson, 1995), situated learning, anchored instruction, and others (see Reynolds, Sinatra, & Jetton, 1996 for descriptions).

For constructivists, "…learning is necessarily a social dialogical process in which communities of practitioners socially negotiate the meaning of phenomena" (Jonassen, et al., 1995, p. 9). This idea suggests that important characteristics of learning involve collaboration among communities of individuals, language as the medium of the message, and conversation as the process by which meaning is constructed.

There is general agreement in the literature (e.g., Cronin, 1997; Jonassen, et al., 1995; Hein, 1991; McGuire, 1996; Warschauer, 1997; Wilson, et al., 1995) regarding constructivist instructional conditions as discussed below. A dominant characteristic of constructivist learning is collaboration among learners. In contrast to objectivist instructional theories, constructivist theories posit that it is through communication with others that learners construct meaning from their experiences. The importance of social negotiation in the learning process makes communication critical. Constructivist instructional environments are designed and implemented with this purpose in mind.

Knowledge as consensus requires communication that involves multiple perspectives. Collaboration occurs when learners communicate their understanding, listen to the views of others, explore alternative perspectives, are challenged in their beliefs, and challenge others. This form of communication requires reflection and introspection for learners to make sense of their experiences. Engagement in real world or authentic tasks provides a context for the learner to construct meaning from their experiences. Learning anchored or situated in a context provides opportunities for learners to construct personal meaning.

In constructivist learning environments, the predominant communication configuration is that of learners to learners (i.e., many to many). In communication between the instructor and individual students (one-to-one) or between the instructor and a group of students (one-to-many) the instructor's role is not to dispense knowledge, but to coach or model meaning-making (Jonassen, 1999).

The associative, hyperlinking, and nonlinear features of the Web environment (Ayersman, 1995) are well suited to support constructivist learning. Cognitive processing theorists view these features as enabling a more accurate representation of the expert's (i.e., instructor's) internal structure of knowledge. For the constructivist, these features are viewed in terms of their capacity to help learners develop unique knowledge representations. To do so requires learner control of the process. Sequencing of content does not emerge from predetermined, hierarchically constructed content (i.e., the expert's representation of knowledge). Instead, sequencing varies as learners build their own knowledge (McGuire, 1996). It is this freedom to control access to information that differentiates constructivist from cognitive processing instruction. These ideas are evident in Cognitive Flexibility Theory were learners have control to "criss-cross" the instructional landscape in order to view subject matter from multiple perspectives (Spiro, et al., 1995). This freedom, however, even in constructivist practice, is not unlimited. Maintaining "purposeful navigation" is difficult as learners can get "lost" and fail to make meaningful interpretations even in closed hypertext environments (McGuire, 1996; Spiro, et al., 1995). Extrapolating to the Web environment, the danger of getting lost in "cyberspace" is even greater. Thus, the instructor must arrange instructional elements (e.g., learner navigation, access to information) to avoid this potential problem.

Instead of using technology tools (i.e., software, authoring and language programs) to implement prescribed strategies that can effectively communicate knowledge to the learner, the constructivist uses technology tools to enhance communication through collaboration. On-line conferencing and e-mail are two technologies that permit communication among learners (many-to-many). These communication technologies are available and easy to use which has made them a tool of choice for collaborative courses (e.g., Jonassen, et al., 1995; Warschauer, 1997).

Instructional Goals and Communication Strategies

There are four primary instructional goals of Web-based instruction based on a cognitive constructivist approach. As was the case with the cognitive processing approach, communication strategies must be identified and implemented to maximize goal attainment. Examples of such strategies (based on Jonassen, 1999, and others) are listed below. In choosing strategies, instructors must consider both the type of communication (i.e., one-to-one, many-to-many) and time elements (i.e., synchronous vs. asynchronous) as they relate to the basic purpose of education (i.e., individual construction of knowledge).

Instructional Goal #1: Present a problem-solving situation in a realistic context.. The primary communication strategy is to select computer-supported collaborative learning software that communicates "real life" problems

in a format and that provides opportunities for students to collaboratively resolve problems (one-to-many and many-to-many, asynchronous).

Instructional Goal #2: Provide opportunities for learners to collaboratively construct knowledge based on multiple perspectives, discussion, and reflection. Communication strategies include (a) selecting software tools that support collaborative learning/communication (many-to-many, synchronous and asynchronous), (b) using audio and video conferencing to facilitate information sharing and discussion among students (many-to-many, synchronous), and (c) employing Internet voice mail to promote immediacy of communications (one-to-many, synchronous).

Instructional Goal #3: Provide opportunities for learners to articulate and revise their thinking in order to insure the accuracy of knowledge construction. Communication strategies include (a) creating bulletin boards to record students' responses for later analysis and reflection (many-to-many and one-to-one, asynchronous), (b) using e-mail to pose questions and solicit information (one-to-many, asynchronous), and (c) using audio and video conferencing to promote discussion and information-sharing (many-to-many, synchronous).

Instructional Goal #4: Create opportunities for the instructor to coach and facilitate construction of student knowledge. Communication strategies include (a) using instant messaging to provide immediate motivation (one-to-one, synchronous), (b) using e-mail to analyze learners' understanding of content and to provide feedback (one-to-one, asynchronous), and (c) using audio and video conferencing to model reasoning and problem-solving skills (many-to-many, synchronous).

The instructor's role in developing Web-based instruction under the cognitive constructivist paradigm is to arrange instructional conditions that foster students' construction of knowledge. In making instructional decisions, the instructor considers learner characteristics in order to establish an environment that supports this process.

Discussion

The educational landscape of the 21st century will be characterized by an unparalleled capacity to link learners and educational providers (Connick, 1997). Learners will increasingly choose to complete educational requirements through Web-based courses offered by a variety of training institutions. As Web-based instruction becomes a dominant educational vehicle, course quality will be evaluated using new criteria. There will be a shift away from measuring quality in terms of educational processes toward the extent to which Web-based instruction enables students to acquire specified competencies. Communication in this virtual environment will play a critical role in student success.

There is mounting evidence that cognitive principles and pedagogical theories can be used to guide the development of effective Web-based courses. Cognitive Processing and Cognitive Constructivist approaches were examined to illustrate how differing approaches produce different outcomes and suggest different communication goals and strategies. Consequently, the authors argue that it is incumbent on Web-based course developers to (a) acquire knowledge of cognitive and pedagogical theories, (b) develop a pedagogical philosophy, (c) design Web-based courses consistent with one's pedagogical approach and philosophical guidelines, (d) acquire skills in using a wide range of internet-based communications technologies, and (e) create both instructor-learner and content-learner communication opportunities that are consistent with philosophical guidelines and course goals.

Given the escalating demands on professionals in almost every discipline to develop Web-based courses, the authors recommend that university training programs require appropriate candidates to demonstrate the knowledge and skill bases identified above. This requirement will serve the interests of both 21st century educators and students.

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