Constructivism and Computer-Mediated Communication in Distance Education

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Abstract

The fields of learning theory and instructional design are in the midst of a scientific revolution in which their objectivist philosophical foundations are being replaced by a constructivist epistemology. This article describes the assumptions of a constructivist epistemology, contrasts them with objectivist assumptions, and then describes instructional systems that can support constructive learning at a distance

Limitations of Distance Learning Technologies

In an effort to supplement or replace live face-to-face instruction, technologicany mediated distance learning has more often than not merely replicated the ineffective methods that limit learning in face-to-face classrooms (Turoff 1995). Too often, potentially interactive technologies are used to present one-way lectures to students in remote locations. However, we believe that the most valuable activity in a classroom of any kind is the opportunity for students to work and interact together and to build and become part of a community of scholars and practitioners (Selfe and Eilola 1989; Bates 1990; Seaton 1993; Nalley 1995). A good learning experience is one in which a student can "master new knowledge and skills, criticany examine assumptions and beliefs, and engage in an invigorating, collaborative quest for wisdom and personal, holistic development" (Eastmond and Ziegahn 1995, 59). Technology used in distance education should facilitate these "good learning experiences" in an "extended classroom model" rather than broadcast teacher-centered lectures and demonstrations (Burge and Roberts 1993). A significant impediment to this goal is the fact that many teachers and instructional designers come to distance education from traditional backgrounds, bringing with them assumptions about teaching and learning that are not theory-based and do not translate well to technologicany mediated instruction (Schieman, Taere, and McLaren 1992).

Our purpose here is to promote well-designed, mediated instruction that moves the teacher from podium to sideline, from leader to coach, from purveyor of knowledge to facilitator of personal meaning making (Romiszowski and de Haas 1989; Beaudoin 1990; Gunawardena 1992; Burge and Roberts 1993). Our belief is that technology can be used to create communities of learners and practitioners and can facilitate the interactions and activities necessary for solving real-world problems (Burge and Roberts 1993). Our focus in this paper is to show how constructivism can help us reconceptualize distance education by using the new technologies to significantly alter how we conduct distance education (Morrison and Lauzon 1992). Constructivist principles provide a set of guiding principles to help designers and teachers create learner-centered, collaborative environments that support reflective and experiential processes. Students and instructors can then build meaning, understanding, and relevant practice together and go far beyond the mere movement of information from instructors' minds to students' notebooks.

The Recent Evolution in Learning and Instructional Design Theory

For the past two decades, the field of instructional design has attempted to accommodate the many changes implied by a paradigm shift from behavioral to cognitive psychology. That process was begun by Winn (1975), who sought to convey a more organismic view of the learner as one who interacts with the environment and acquires knowledge, skills, and competence from it, rather than a reactive view of the learner as one who is controlled by instruction. Winn promoted the use of cognitive instructional strategies, less reductionistic forms of analysis, and a more holistic approach to learner interactions as a means for achieving that view (Winn 1990). Cognitive models and processes of instructional design have emphasized mental constructs such as information processing (Champagne, Klopfer, and Gunstone 1982; Wildman and Burton 1981); schemata, knowledge structures, and other knowledge states (DiVesta and Rieber 1987); and learning strategies (Jonassen 1985). All of these models have emphasized the role of mental processing in learning.

Until recently, cognitive psychology was the emergent paradigm of learning. However, the field of cognitive psychology, especially in the sub-domain of artificial intelligence, is now embroned in another scientific revolution. The dominant paradigm in cognitive psychology, the

symbolic reasoning paradigm, focuses on describing the ways that learners process information and on the resulting knowledge states. Symbolic reasoning theorists assume that what is represented in the mind is a reflection of what exists in the real world. Symbolic reasoning relies on abstract formalisms, such as rules, for describing these knowledge states and the practice that produces them (Anderson 1983). That is, reasoning can be conceived of in terms of a replicable set of processes that can be represented symbolically. All of these assumptions infer an orderly process of knowledge acquisition that can be affected by the conditions of learning, just as the behaviorists believe.

The symbolic reasoning paradigm is currently being challenged by situated learning models (Clancy 1991; Derry 1992). Cognitive psychology has modeled thinking in terms of abstract, symbolic reasoning processes. Situated learning theory, however, emphasizes the role of context in learning and questions whether learning is an individualistic or social phenomenon. The symbolic reasoning paradigm seeks generalizable and abstract models of learning to describe how individuals think. Symbolic theorists believe that various forms of expert reasoning can be modeled and mapped onto learners' thinking patterns. That mapping process can be controlled by instructional conditions. The situated learning paradigm, on the other hand, argues that most learning is context-dependent. What is learned (the meaning that is constructed by the learner) is indexed by the experience surrounding the learning, which assigns meaning to what is learned. As a result, what is learned in the process of solving real-world problems is much richer and better understood because of this indexing. Because classroom lectures provide little of this richness, few connections are made. Situated learning and social construction theorists also believe that learning is necessarily a social, dialogical process in which communities of practitioners socially negotiate the meaning of phenomena. That is, learning is conversation, and the thinking and intelligence of a community of performers or learners is distributed throughout the group. Knowledge and intelligence is not the privilege of an individual, but rather is shared by the community of practice. The assumptions of the symbolic reasoning and situated learning positions are contrasted in Table 1.

The revolution in learning theory and instructional design has transcended the behaviorism-cognitivism dialectic and entered a new era of theorizing. The symbolic reasoning paradigm does not accommodate the dynamic nature of learning, emergent properties of thinking, plausible rather than exact reasoning, learning situated in context, and the indeterminism that always seems to subjugate our expectations ahout learning outcomes. These issues are philosophical as well as psychological.

Table 1. Contrasting Assumptions of Paradigms

Symbolic Reasoning		Situated Learning
	Knowledge	
objective		subjective
independent		contextualized
stable		relative
applied		situated in action
fixed		fluid
	Learning	
objectivist		constructivist
product-oriented		process-oriented
abstract		authentic
symbolic		experiential
	Memory	
stored representations		connections, potentials
	Knowledge Representation	
functionally equivalent to real world		embedded in experience
replication of expert		personally constructed
symbolic, generalized		personalized
	Instruction	
top down		bottom up
deductive		inductive
application of symbols		apprenticeship
	Computational Model	
symbolic reasoning		connectionist
production rule		neural network
symbol manipulation		probabilistic, embedded

On a philosophical level, the symbolic reasoning-situated learning dialectic is discussed in terms of objectivist and constructivist epistemologies (Jonassen 1991; Duffy and Jonassen 1992). The dominant and traditional objectivist paradigm (which provides the foundation for symbolic reasoning) assumes that the world is structured, that structure can be modeled and mapped onto the learner, and that the goal of the learner is to "mirror" reality as interpreted by the instructor. Knowledge is

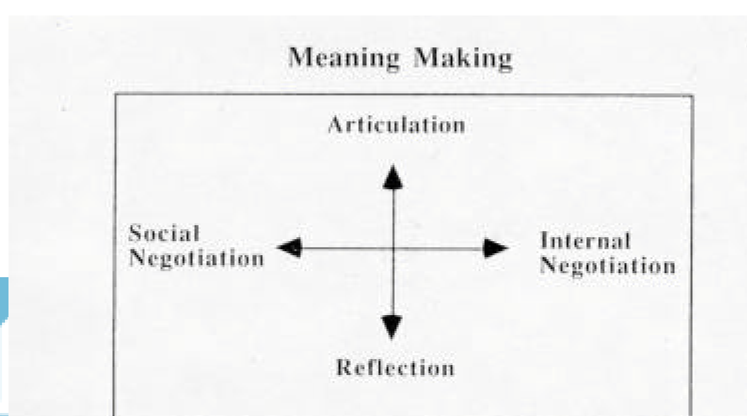
external to the knower and so can be transferred (communicated) from one person to another. The learner´s role is to remember and reproduce the knowledge that is transmitted by the teacher or professor. These assumptions are most often manifested in what Schank and Jolla (1991) call the "sponge method" of instruction. In the sponge method, the teacher imparts knowledge to the learners, who absorb it. During the assessment phase, the knowledge that learners should have acquired from the teacher is "wrung out" of them. The quality of learning is considered a function of how well the Student can reproduce the thinking of the instructor.

Constructivism (which provides the psychological/philosophical foundation for situated learning) begins with a different set of assumptions about learning. Constructivists believe that our personal world is constructed in our minds and that these personal constructions define our personal realities. The mind is the instrument of thinking which interprets events, objects, and perspectives rather than seeking to remember and comprehend an objective knowledge. The mind filters input from the world in the process of making those interpretations. The important epistemological assumption of constructivism is that knowledge is a function of how the individual creates meaning from his or her experiences; it is not a function of what someone else says is true. Each of us conceives of external reality somewhat differently, based upon our unique set of experiences with the world and our beliefs about them.

Constructivist educators strive to create environments where learners "are required to examine thinking and learning processes; collect, record, and analyze data; formulate and test hypotheses; reflect on previous understandings; and construct their own meaning" (Crotty 1994, 31). The constructivist sense of "active" learning is not listening and then mirroring the correct view of reality, but rather participating in and interacting with the surrounding environment in order to create a personal view of the world. Constructivists engage the learners so that the knowledge they construct is not inert, but rather usable in new and different situations. The purpose of this revolution in learning theory is not so much to predict learning outcomes from instructional interventions as "to discover and to describe formally the meanings that human beings create out of their encounters with the world, and then to propose hypotheses about what meaning-making processes were implicated" (Bruner 1990, 2).

Meaning making, according to constructivists, is the goal of learning processes; it requires articulation and reflection on what we know. The

processes of articulation and reflection involve both internal negotiation and social negotiation (Figure 1). We debate, wrestle, and argue with ourselves over what is correct, and then we negotiate with each other over the correct meaning of ideas or events. Observe the development of any political decision for an example of these processes. Meaning is the understanding that we derive from these processes; it is a reflective form of knowledge(Norman 1993). The application of that meaning in real-world practice is what Norman (1993) refers to as experiential knowledge. Both experiential and reflective knowledge emerge from our interactions with the world, and both are required for performing most real-world tasks. Therefore, an important emphasis of constructivist beliefs about learning is the need for embedding learning in real-world situations in which learners function as a part of a community of practitioners helping to solve real-world problems (Lave and Wenger 1991).



Implications of Constructivism for Learning and Instruction

Before discussing the ways in which constructivist assumptions about learning imply a new approach to instruction, We must first acknowledge a bias: Constructivist instruction is an oxymoron. Learning, we believe, can be best facilitated through the design and implementation of

constructivist tools and learning environments that foster personal meaning-making and discourse among communities of learners (socially negotiating meaning) rather than by instructional interventions that control the sequence and content of instruction and that seek to map a particular model of thinking onto the learners. An important inference of this belief is that the role of the designer shifts from creating prescriptive learning situations to developing environments that engage learners and require them to construct the knowledge that is most meaningful to them. The principles by which those learning environments may be built focus on four general system attributes: context, construction, collaboration, and conversation. Constructivist environments engage learners in knowledge construction through collaborative activities that embed learning in a meaningful context and through reflection on what has been learned through conversation with other learners.

Context includes features of the "real world" setting in which the task to be learned might naturally be accomplished. These features, which are replicated as faithfully as possible in the learning environment, may include the physical, organizational, cultural, social, political, and power issues related to the application of the knowledge being learned. Attention to context, a central tenant of constructivist learning theories such as situated cognition and cognitive apprenticeships, prevents learning environments from being "sterilized" into predetermined instructional sequences (Brown, Collins, and Duguid 1989).

Construction of knowledge is the result of an active process of articulation and reflection within a context. The knowledge that is created is a product of the mind and results from the individual's experiences with and interpretations of the context (Jonassen 1991). Those experiences can be encountered in learning environments as well as in the real world, Learning environments are constructivist only if they allow individuals or groups of individuals to make their own meaning for what they experience rather than requiring them to "learn" the teacher's interpretation of that experience or content.

Collaboration among learners or performers occurs throughout the learning process.Collaboration aids in developing, testing, and evaluating different beliefs and hypotheses within learning contexts. Through the process of articulating covert processes and strategies, learners are able to build new and modify existing knowledge structures. Collaboration, as we will later discuss, is the focus of constructivist, distance learning activities (Seaton 1993).

Conversation is entailed by collaboration. Individuals and groups must negotiate plans for solving situated problems before initiating those plans. This planning involves reflecting on what is known, what needs to be known, the viability of various plans, and their potential effectiveness. Conversation is an essential part of the meaning-making process because knowledge, for most of us, is language mediated.

How can these beliefs be implemented in distance learning settings? Earlier, we indicated that too many distance learning initiatives use technology to deliver instruction in traditional, objectivist ways. How can learning technologies be used to facilitate internal negotiation, social negotiation, exploration, and self-assessment, in distance learning settings? In the next section of the paper, we will describe briefly a number of options.

Constructivism at a Distance

Distance education is defined by Moore (1990, xv) as "all arrangements for providing instruction through print or electronic communications media to persons engaged in planned learning in a place or time different from that of the instructor or instructors." Much of the literature on distance education, as represented by this definition, has placed an emphasis on the logistics of instructional delivery and technologies (Keegan 1983). Too often the result is merely transmission of the instructor's image to remote cities; less often instruction is supported by limited, two-way, interactive communication between the instructor and remotely located students. Research in this area has just begun to consider the interaction of personal and situational variables involving the learner, learner behaviors, and the environment (see, for example, Burge and Roberts 1993; Gibson 1990).

Increasing recognition of the potential of computer-mediated communications, computer-supported collaborative work, computer learning environments, and computer-based cognitive tools has encouraged innovative approaches to the design of distance learning. New technologies have contributed to a movement away from the duplication of traditional instructional methods, both in the classroom and at a distance (Turoff 1995), toward a more resource-based approach to instruction that no longer emphasizes the teacher as the main source of knowledge (Smith and Kelly 1987; Beaudoin 1990; Gunawardena 1992). This perspective within distance education aligns itself with the principles of constructivism (Crotty 1994; Garrison 1993). Although a few authors have

promoted constructivist approaches to distance education, none has recommended any specific strategies for accomplishing that goal. In this article we offer a number of recommendations for employing distance education technologies to support constructive learning.

A constructivist approach to knowledge construction and learning, we believe, can be well supported in distance education settings through a variety of technologies. Technology- supported environments -computer-mediated communication, computer-supported collaborative work, case-based learning environments, and computer-based cognitive tools, for example- can offer the field of distance education alternative approaches to facilitating learning (see Figure 2). These constructivist environments and tools can replace the deterministic, teacher-controlled model of distance instruction with contextualized work environments, thinking tools, and conversation media that support the knowledge construction process in different settings. Although an exhaustive review is beyond the scope of this article, we will provide a brief description of these environments.

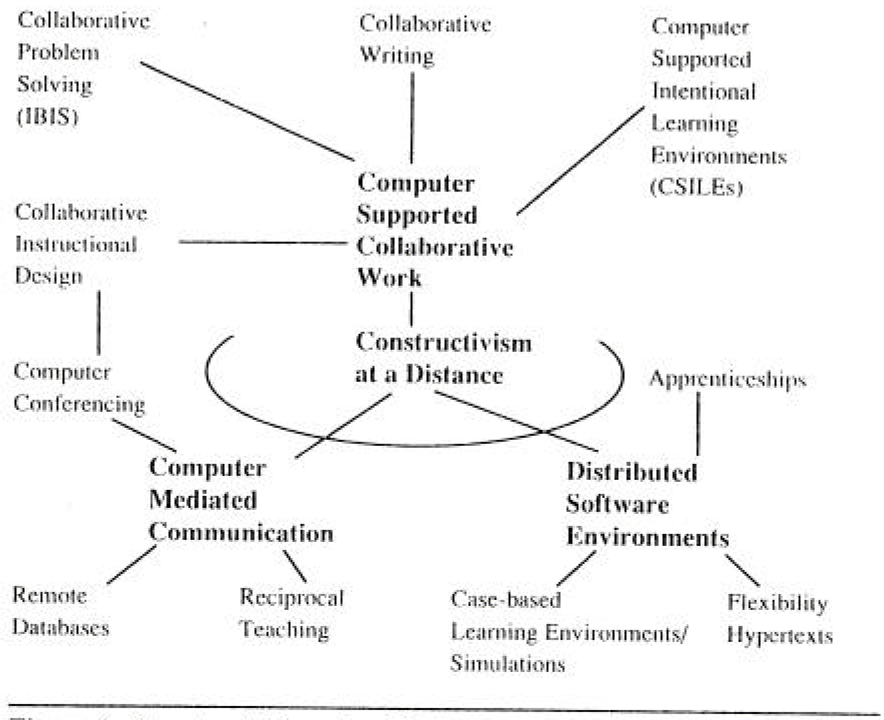


Figure 2. Constructivism at a Distance

Computer-Mediated Communication Technologies

Computer-mediated communication (CMC) refers to the use of networks of computers to facilitate interaction between spatially separated learners; these technologies include electronic mail, computer conferencing, and on-line databases. The most prominent applications of CMC -computer conferencing and electronic mail- support sophisticated synchronous (real-time) or asynchronous (delayed) group communication.

The power of computer conferencing and electronic mail as constructivist learning tools and environments lies in their capabilities to support conversation and collaboration. Dyads or groups can work together to solve problems, argue about interpretations, negotiate meaning, or engage in other educational activities including coaching, modeling, and .scaffolding of performance. While conferencing, the learner is electronically engaged in discussion and interaction with peers and experts in a process of social negotiation. Knowledge construction occurs when students explore issues, take positions, discuss those positions in an argumentative format, and reflect on and re-evaluate their positions. As a result of contact with new or different perspectives, these activities may contribute to a higher level of learning through cognitive restructuring or conflict resolution, leading to new ways of understanding the material (Harasim 1990). Sharing knowledge through an electronic medium also aids the overt exchange of naturally covert processes and strategies with other on-line learners in order to solve collective or individual problems. These exchanges can be viewed by all learners and contribute to the formation of a collaborative mental model in a specific subject area.

In comparison with a traditional classroom, where the teacher contributes up to 80% of the verbal exchange (Dunkin and Biddle 1974; McDonald and Elias 1976), on-line computer conferencing shows instructor contributions of only 10-15% of the message volume (Harasim 1987; Winkelmans 1988). This type of interaction pattern exemplifies the constructivist design model of reciprocal teaching through the use of written rather than verbal dialogue. Reciprocal teaching was originally designed as a procedure for teaching poor readers to approach text as successful readers do (Palincsar, Ransom, and Derber 1989). This method is easily adaptable to the on-line environment through the fundamental principle of systematically alternating control between teacher and students. Allowing learners to generate questions, summarize content, clarify points, and predict upcoming events is also

applicable to other educational tasks. When performed online, these activities can facilitate the discussion of various structural relationships within the subject matter. Social negotiation of the structure of ideas represented in the written content may also induce knowledge construction.

Electronic mail, news groups, and computer conferencing support the development of discourse communities, groups of individuals who share and discuss common interests and goals. Over 2000 NetNews groups support discussion of topics as diverse as baseball, poetry, model railroading, *Star Trek* memorabilia, abortion, gun control, and religion. When focused on learning utcomes and scaffolded by different discourse structures, these discourse communities can become more purposive "communities of learners and thinkers" (Brown and Campione 1990) or "knowledge building communities" focusing on problems and depth of understanding, decentralized control, and a broader knowledge community (Scardamalia and Bereiter 1993/1994).

Accessing remote, on-line databases may also facilitate the construction of knowledge. Thousands of news networks, hundreds of commercial databases, and thousands of bulletin boards support self-directed exploration of information. Retrieved information can be used to support positions in computer conferencing discussions, for collaboration on a particular topic, or for satisfying personal curiosity. Knowledge construction is fostered through the intentional searching process and through linking information to the learner's own schema. Merely locating information in a database does not necessarily lead to learning. Critical to the knowledge construction process is the articulation of a meaningful purpose for learning; it is the intentional, goal-oriented behavior of the learner while performing the database search that facilitates and strengthens connections between elements of information and that results in higher-order thinking and meaningful learning.

Computer-Supported Collaborative Work

Cornputer-supported collaborative work (CSCW) combines communications and computer technologies to support various activities in groups of varying size, permanence, and structure (Olson, Olson, and Kraut 1992). CSCW tools help groups structure work through group decision support systems, project management tools, electronic conferencing systems, and shared editors. CSCW technologies can support groups across a distributed environment. For example, collaborative problem solving in corporations can be supported by the IBIS hypertext

environment (Conklin and Begeman 1987), which provides an argument structure including issue, position, and argument nodes. Users add their comments about the problem under discussion, producing a logical discourse that usually results in an effective and acceptable solution. These environments help collaborative groups construct a common understanding of the problem being solved and negotiate the most appropriate solution to that problem. Construction and negotiation are the hallmarks of constructive learning.
Research laboratories involved in CSCW are exploring the use of video transmissions to support informal communication in the workplace (Heath and Luff 1992). This type of technology has interesting ramifications for distance education, as well. Two-way real-time video transmission of information implies a new definition of real-world context. Although video-mediated, constructivist learning environments could potentially include the actual environment or a close facsimile with which the learner could remotely interact. These collaborative problem-solving situations enhance knowledge construction through the addition of visual information and remote interaction with other learners. The video transmission of authentic, realistic contexts adds a significant dimension to anchored instruction and situated learning environments (see, for example, Cognition and Technology Group at Vanderbilt 1992a, 1992b, 1992c, 1993a, and 1993b).

Computer-supported intentional learning environments (CSILEs) are another distance education technology that can assist learners in knowledge construction. CSILEs are educational knowledge media systems that allow different types of information (text, drawings, graphs, timelines, etc.) to be entered into a common database where they are available for retrieval, review, and contribution (Scardamalia et al. 1989), CSILEs, which can be implemented both locally and at a distance, promote intentional control over learning by providing an environment that requires students to plan, monitor, set goals, and solve problems. CSILEs require learners to reflect on their personal knowledge, state learning intentions, and publish ideas to a communal database, thus producing cumulative, progressive results for the group (Scardamalia and Bereiter 1993/1994).

CSILEs promote knowledge construction through the procedural facilitation process and the building of a collective database that provides the procedural facilitation process and the building of a collective database that provides open access to the learning context, facts, and information needed for solving specific problems. Procedural facilitation also provides a scaffolding effect by providing learners with temporary support

processes until they are prepared for more complex strategies and information. Making knowledge construction activities overt contributes to this process through internal negotiation and deliberate actions such as goal setting, identifying and solving problems of understanding, and connecting old and new knowledge (Scardamalia et al. 1989).

Situated, Case-Based Learning Environments

Constructivist correspondence instruction may be delivered in self-contained, computer-delivered, case-based learning environments. Rather than conveying the single interpretation of- the instructor in a workbook, these environments provide rich, contextualized problem-solving activities that learners can experience individually or in groups. Available on disks or CD-ROMs, lessons can be used remotely by learners on their personal computers. Traditionally, correspondence Courses -in distance education have involved paper-based independent study materials for courses delivered through the mail system. More recently, correspondence instruction has included electronically delivered "presentation-type" computer-assisted instruction (CAI) with limited interactive capabilities (Maurer and Makedon 1991). Designed according to conventional objectivist notions, this type of CAI is prevalent ill distance education and in the classroom (Santoro 1995). However, hypermedia-based learning environments designed within a constructivist framework may better foster knowledge construction than the oversimplified reductionistic delivery of information provided by traditional CAI. We next describe some examples of this type of environment.

Spiro, Feltovich, Jacobson, and Coulson (1992) advocate the design of hypertext environments that reflect the cognitive characteristics necessary for knowledge construction. The central tenet of cognitive flexibility theory is improvement of learners' understanding and their transfer of information through exposure to the same material, at different times, in rearranged contexts, for different purposes (Spiro et al. 1992). Especially well suited for ill-structured domains involving complex concepts and examples, cognitive flexibility theory in hypermedia environments promotes the production of flexible knowledge representations in learners.

Numerous other models can be used for structuring case-based learning environments. Among the most prominent is "anchored instruction," which bases instruction ill appealing and realistic events or problems,

This model requires complex problem solving wherein students must define the problem, identify resources, set priorities, and explore alternative solutions. In other words, they must use the same skills and abilities required during realistic, outside-the-classroom problem-solving and decision-making activities as opposed to working the simplified, compartmentalized, and decontextualized problems common in traditional classrooms (Cognition and Technology Group at Vanderbilt 1992a, 1992b, 1992c, 1993a, and 1993b). Anchored instruction typically uses a video-based presentation format because of the dramatic power of the medium with its multiple modalities and realistic imagery, and because of its omnipresence in our culture. A problem is introduced in a video presentation that uses actors and a narrative format for interest. Solving the problem requires a generative learning format in which students must identify pertinent information and select among multiple solution paths.

Cognitive Tools for Knowledge Representation and Construction

Cognitive tools also known as Mindtools (Jonassen in press), engage and facilitate cognitive processing, hence the term "cognitive tools" (Kommers, Jonassen, and Mayes 1992). Cognitive tools are both mental and computational devices that Support, guide, and extend the thinking processes of their users (Derry 1990). They are knowledge-construction and facilitation tools that can be applied to a variety of subject-matter domains. Students cannot use these tools without thinking deeply about the content that they are studying; if they choose to use these tools, they will facilitate their own learning and meaning-making processes. cognitive tools include (but are not necessarily limited to) databases, spreadsheets, semantic networks, expert systems, computer conferencing, multimedia/hypermedia construction, computer programming, and microworld learning environments.

Cognitive tools are computer applications that require students to interpret and organize personal knowledge - processes critical to the knowledge construction process - in order to use them. Using computers as cognitive tools represents learning with technology by entering into an intellectual partnership with the computer (Salomon, Perkins, and Globerson 1991). Learning with cognitive tools depends "on the mindful engagement of learners in the tasks afforded by these tools": students work with computer technology, instead of being controlled by it.

For distance learning, cognitive tools are powerful because they can support the thinking engaged by any of the other kinds of environments

in a distributed manner. The products of these tools call be shared in collaborative work environments or through computer conferencing. They are general-purpose thinking tools that can be used individually or ill groups to foster knowledge representation and construction.
To summarize, designing and implementing constructivist learning environments for distance education are complex and novel functions in an educational community accustomed to replicating traditional modes of instruction. Probably the most important issue in designing constructivist environments is authenticity, the extent to which the environment faithfully reflects the ordinary practices of the culture (Brown, Collins, and Duguid 1989). According to Wiggins (1993), both distance and local learning environments should have the following characteristics:

- be centered on engaging and worthy problems or questions of importance in which Students must construct knowledge for effective performance
- include tasks that are either replicas of or analogous to the kinds of real-world problems faced by citizens, consumers, or professionals in the field ,
- provide access for the student to resources commonly available to those engaged in analogous real-life problems or activities
- present problems requiring a repertoire of knowledge, Judgment in determining appropriate application of knowledge, and skills in prioritizing problem classification and solution phases

Tasks also should be supported by deliberate collaboration and conversation among the community of participants. All of these attributes are grounded in answers to the question "What do professionals in the real world get paid to do?" Few, if any, are paid to memorize information and take examinations.

Conclusions

Constructivism can provide theoretical bases for unique and exciting distance learning environments. These environments should emerge from authentic tasks, engage the learners in meaningful, problem -based thinking, and require negotiation of meaning and reflection oil what has been learned. Computer-mediated communication (especially computer conferencing), computer-supported intentional learning environments, and computer-supported collaborative work environments all support

constructive learning. Distance learning will be more effective when it takes place in stimulating learning environments designed oil constructivist principles. It is important to note that constructive learning will be appropriately implemented only if students are evaluated, as well as instructed, constructively; such evaluation will require assessment methods that reflect the constructivist methods embedded in the learning environments. Constructivist evaluation is the topic of another paper.

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