anthropological systems

Activity Theory as a Framework for Designing Constructivist Learning Environments

☐ David H. Jonassen
Lucia Rohrer-Murphy

The epistemic assumptions of constructive learning are different from those of traditional instruction, so classical methods of needs and task analysis are inappropriate for designing constructivist learning environments (CLEs). This paper argues that activity theory provides an appropriate framework for analyzing needs, tasks, and outcomes for designing CLEs. Activity theory is a socio-cultural, socio-historical lens through which designers can analyze human activity systems. It focuses on the interaction of human activity and consciousness within its relevant environmental context. Since conscious learning emerges from activity (performance), not as a precursor to it, CLEs should attempt to replicate the activity structures, tools and sign systems, socio-cultural rules, and community expectations that performers must accommodate while acting on some object of learning. After explicating assumptions of activity theory and briefly describing the components of CLEs, this paper describes a process for using activity theory as a framework for describing the components of an activity system that can be modeled in CLEs.

☐ In order for any discipline to survive, it must accommodate changes in theory and practice and do so in a way that adds value to the discipline (Kuhn, 1972). In recent years the field of instructional design has begun to accommodate constructivist beliefs and practices related to learning, as evidenced by the recent focus on the use of constructivist learning environments (Jonassen, 1999), open-ended learning environments (Land & Hannafin, 1996), microworlds, anchored instruction (Cognition and Technology Group, 1992), problem-based learning (Savery & Duffy, 1995), and goal-based scenarios (Schank & Cleary, 1995), hereafter referred to collectively as constructivist learning environments (CLEs). Constructivist approaches to learning are clearly based on distinctly different epistemic and pedagogical assumptions than classical approaches to instructional design (Jonassen, 1991).

As with nearly every innovation, a problem with constructivism for instructional design has been that, while detailed conceptions and examples of the kinds of CLEs exist, less practical advice is available on how to construct them and especially how to perform the analysis phase of the design and development process for CLEs. Although design recommendations are forthcoming (Reigeluth, 1999), none explicate methods for needs or task analysis. If we agree that the epistemic beliefs of constructivist learning approaches are fundamentally different from those of traditional instruction, classical methods of needs and task analysis are inappropriate for designing CLEs. For example, behavioral and job analysis techniques and learning analysis methods, such as hierarchical task (prerequisites) analysis, or even cognitive task analysis

methods, cannot provide an appropriate foundation for designing CLEs because they assume that relevant knowledge can be embedded in the instruction for transfer to the learner in any context. Therefore, designers committed to designing and implementing CLEs need an appropriate set of design methods for analyzing learning outcomes and designing CLEs that are consistent with the fundamental assumptions of those environments.

We argue in this paper that a powerful framework for analyzing needs, tasks, and outcomes for designing CLEs is provided by activity theory. It is a useful framework because the assumptions of activity theory are very consonant with those of constructivism, situated learning, distributed cognitions, case-based reasoning, social cognition, and everyday cognition that underlie CLEs (Jonassen & Land, 1999). It is also useful because activity theory has been used often enough in designing human-computer interactions in order to provide a clear operational framework for designing CLEs.

In this paper, we first elaborate the assumptions that underlie activity theory, then describe the components of an activity system, and finally describe how activity theory may be used to analyze activities and settings for the purpose of designing CLEs.

ACTIVITY THEORY

Activity theory has its roots in the classical German philosophy of Kant and Hegel, which emphasized both the historical development of ideas as well as the active and constructive role of humans. This philosophy provided the foundation for the more contemporary philosophy of Marx and Engels and the Soviet cultural-historical psychology of Vygotsky, Leont'ev, and Luria (Kuutti, 1996) on which activity theory is based. Activity theory is not a methodology. Rather it is a "philosophical framework for studying different forms of human praxis as developmental processes, both individual and social levels interlinked at the same time" (p. 532). Activity theory adopts Marx's dialectic materialist view of activity and consciousness as dynamically interrelated (Leont'ev, 1972), which provides an alternative perspective to the mentalistic and idealist views of human knowledge that claim that learning must precede activity. Activity theory posits that conscious learning emerges from activity (performance), not as a precursor to it. So activity theory provides us with an alternative way of viewing human thinking and activity.

Activity theory is a powerful socio-cultural and socio-historical lens through which we can analyze most forms of human activity. It focuses on the interaction of human activity and consciousness (the human mind as whole) within its relevant environmental context. This is essential for designing CLEs, which are activity-oriented. Also, the instructional design community needs to be more concerned with the context in which learning and performance, as well as the design process itself, occur (Tessmer & Richey, 1997). Because contemporary, anthropological learning theories claim that learning occurs only in the context of meaningful activity, it is important to analyze the activity and the context as part of the instructional design process. Activity theory is a useful framework for understanding the totality of human work and praxis (Bødker, 1991a), that is, activity in context.

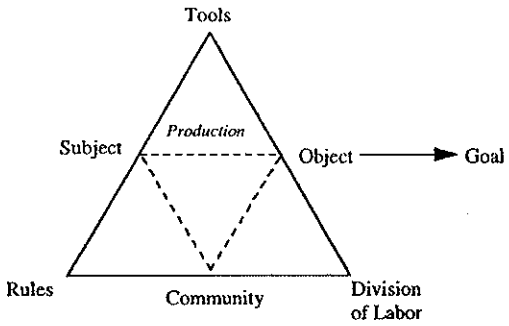
Activity cannot be understood or analyzed outside the context in which it occurs. So when analyzing human activity, we must examine not only the kinds of activities that people engage in but also who is engaging in that activity, what their goals and intentions are, what objects or products result from the activity, the rules and norms that circumscribe that activity, and the larger community in which the activity occurs. These are all parts of the activity system, which we will briefly describe next.

ACTIVITY SYSTEM

The most appropriate unit of analysis is activity. The components of any activity are organized into activity systems (Engeström, 1987), a model of which is depicted as a triangle in Figure 1. The primary focus of activity systems analysis is the top triangle of Figure 1 (the *production* of some object), in which the activity is accomplished. The production of any activity involves a subject, the object of the activity, the tools that are

used in the activity, and the actions and operations that affect an outcome (Nardi, 1996).

Figure 1 ☐ Activity system



The subject of any activity is the individual or group of actors engaged in the activity. For example, in an instructional design context, the subject may a single designer or a team consisting of designers, a manager, subject matter experts, and media producers.

The object of the activity is the physical or mental product that is sought. The object is acted on by the subject. It represents the intention that motivates the activity. For the instructional design example, the object of instructional design may be a curriculum design, hypertext program, workshop, or a videotape that is produced. Whatever it is, the object is transformed in the course of activity, so it is not immutable (Nardi, 1996).

Tools can be anything used in the transformation process (physical, such as hammers or computers or mental, such as models or heuristics). The use of culture-specific tools shapes the way people act and think. For the instructional design example, tools may consist of the design models and methods, the software production tools, project management system, or any other kind of tool that instructional designers use to transform the object (the instructional materials). That is, the tools alter the activity and are, in turn, altered by the activity. For example, using an inquiry design model will result in dramatically different instructional materials (object) than a direct instruction model. Yet the inquiry model that is used will be adapted with each new application. It cannot be applied identically in different contexts, as many traditional design models assume. We can even think of activity theory itself as a mediating tool for research and development. In the context of this article, it recommends an approach to analyzing situations for instructional design.

The activity consists of a goal-directed hierarchy of actions (see Figure 2) that are used to accomplish the object—the tasks, actions, and operations that transform the object. Activity (e.g., designing instructional materials) is the performance of conscious actions and consists of chains of actions (such as needs assessment, objective writing, drawing graphics, shooting video, etc.). Actions are chains of operations (e.g., camera operations, spreadsheet entries, telephone calls). All operations are actions when they are first performed because they require conscious effort to perform. With practice and internalization, activities collapse into actions and eventually into operations, as they become more automatic, requiring less conscious effort. The reverse dynamic is also possible: operations can be disrupted and become actions. So the relationships among activities, actions, and operations are dynamic, as indicated by the bi-directional arrows in Figure 2.

Figure 2 ☐ Hierarchical nature of activities, actions & operations

Activity	-	Motive
⇧⇩		⇧⇩
Action	-	Goal
⇧⇩		⇧⇩
Operation	-	Conditions

We will use the instructional design process to exemplify the activity theory model (Figure 1) because it is familiar to the readers of this journal. If the goal of the activity were "solving a skill-knowledge problem by designing, developing, implementing, and evaluating instruction," the subject would be the individuals and

work groups that would be formed in the organization to fulfill goals (efficient and effective instruction) through the activity of instructional design and development. That activity would consist of numerous actions: conduct needs assessment, perform task analysis, design instructional interactions. These actions are likely to be undertaken by individuals while the activity (instructional design) would likely be a group responsibility. Although the object of the activity would be efficient and effective instruction, the form and function of that object is likely to be modified as the activity unfolds. The tools, signs, and instruments would include the design models and methods employed (e.g., Dick and Carey, critical incident method, syntactic analysis), the physical apparatus and tools (computers, fax machines, telephones, video cameras), and reasoning (e.g., problem solving skills, task decomposition, synthetic thinking) that mediate the group's activity toward designing and developing the instruction. The community consists of the interdependent aggregate (e.g., designers within the organization, subject matter experts, designers within professional associations, customers) who share (at least to some degree) a set of social meanings. Rules inherently guide (at least to some degree) the actions or activities acceptable by the community, so the signs, symbols, tools, models, and methods that the community uses will mediate the process. For example, corporations that emphasize efficiency may not accept constructivist models and methods of learning to mediate the design activity. The division of labor prescribes the task specialization (designers, developers, producers) by individual members of groups within the community or organization. The outcome, of course, is the form of instruction that is developed and implemented.

The point of this illustration is not simply to recast familiar activities in new terminology. Traditional conceptions of instructional design assume that knowledge (both as an object and outcome of instructional design) can be transferred and acquired by learners. Activity theory, on the other hand, focuses on the dynamic relationship between consciousness and activity (Nardi, 1996). Rather than being a process of knowledge transmission, knowledge is socially constructed based on the intentionality, history, culture, and tool mediation used in the process. Consciousness is not a set of discrete, disembodied acts (design, decision making, classifying, remembering) as conceived by traditional conceptions of learning. Rather, consciousness is the result of everyday practice. The conscious process of meaning making for any actor or group of actors in the network emerges from activity or the personal reflection on activity. Next, we will elaborate some of the assumptions underlying activity systems and activity theory.

ASSUMPTIONS OF ACTIVITY THEORY

Activity: Minds in Context

The most fundamental assumption of activity theory is the unity of consciousness and activity (Kaptelinin, 1996). Activities are the human interactions with the objective world and the conscious activities that are a part of those interactions. Rather than learning before acting, as traditional theories prescribe, activity theory believes a priori that the human mind emerges and exists as a special component of interactions with the environment, so activity (sensory, mental, and physical) is a precursor to learning. For example, instructional designers understand the instructional design process only through practicing instructional design in some context. They can memorize its features through direct instruction, but they understand what the process means only through performing it.

The learner (the *subject* in activity systems, see Figure 1) is the central, driving character in defining activity. While traditional theories of learning assume a Cartesian mind-body dualism with respect to the mind and external behavior, activity theory challenges that separation. Mind and body (mental and physical) are interrelated, so knowing can only be interpreted in the context of doing.

Not only do activity and consciousness coexist, they are mutually supportive. There is a reciprocal regulatory feedback between knowledge and activity (Fishbein, Eckart, Lauver, van Leeuwen, & Langemeyer, 1990). As we act, we gain knowledge, which affects our actions,

which changes our knowledge, and so on. This transformational process is critical to the activity-theory conception of learning. Consciousness informs activity, which embeds consciousness. As novice designers perform instructional design activities, they come to better understand the process, which in turn affects the way they perform instructional design activities, which affects their performance.

Consciousness in the World

Activity theory conceptualizes consciousness much differently than traditional cognitive psychology. Consciousness is *not* a set of discrete, disembodied acts (e.g., decision making, classifying, remembering) that are regulated by executive control mechanisms (Nardi, 1996), which is the way that instructional designers typically analyze conscious knowledge. Rather, consciousness is the phenomenon that unifies attention, intention, memory, reasoning, and speech (Vygotsky, 1978). Consciousness is manifested in practice—"you are what you do" (p.7). What you do is embedded in a social matrix, composed of people and artifacts (physical tools and sign systems) that are used in the activity. Therefore, it is necessary to analyze the activities in which performers engage in the context of the performance. For example, designers who work for a school district conceive of themselves and the design process differently than do designers who work for large corporations, because the systems of people (their goals, needs, and beliefs) and artifacts change the nature of the conscious activity. That is, consciousness is embedded in the wider activity system that surrounds an individual's activities, so that changes in the physical, mental, or social conditions of a person's situation are internalized and directly reflected in the person's conscious activities. If a company implements new design processes, it redefines the designers' understanding of their job and the activities that comprise it.

Intentionality

All animals, including humans, interact with their environments and learn about their world through those interactions in order to fulfill some goal. Activity theory focuses on the purposeful actions that are realized through conscious intentions.

Before intentions are manifest in actions in the real world, they are planned. Humans orient their activity and plan their activities. Their intentions and plans are not rigid or accurate descriptions of the intended action, but rather are always incomplete and tentative. Nearly every instructional design project, for instance, is adjusted, reconceptualized, and renegotiated during the design and development process. According to activity theory, intentions emerge from contradictions that individuals perceive in their environment, such as differences between what they believe they need to know in order to accomplish a goal and what they do, in fact, know at any point in time. Their intentions, however, can exist only in the context of the intended activity.

Object-Orientedness

So, activity theory claims that learning and doing are inseparable, and that they are initiated by an intention. What is the source of that intention? Intentions are directed at objects of activity (see activity system in Figure 1). The object of activity can be anything, so long as it can be transformed by subjects of the activity system. Objects may be physical objects (e.g., a house that is built), soft objects (e.g., computer program), or conceptual objects (e.g., a theory or model of activity that is negotiated). The object of an instructional designer, for example, may be the objectives written, the HTML file coded, or the conversation conducted by that designer. The transformation of that object (e.g., completion of code) moves the subjects toward the accomplishment of their goal (Figure 1). Because this transformation process continues to motivate activity (e.g., getting the code to work), the object of activity focuses the intended actions on the object. The transformed object is the motive of the activity.

Just as environmental cues provide affordances for perceptions (Gibson, 1979), objects provide affordances for activity. The object of activity affects the nature of the activity, which affects the object in a dynamic relationship.

Extending the analogy, different objects provide different affordances. That is, different objects require or engage different activities. The affordances of the object alter the role of consciousness (Nardi, 1996), but there is always an asymmetry between people (subjects) and objects. However, it is important to note that, unlike ecological psychology, humans have intentions and consciousness; objects do not.

Community: A Dialectic Context

As stated before, activities are socially and contextually bound. So, any activity system can be described only in the context of the community in which it operates (see Figure 1). The community negotiates and mediates the rules and customs that describe how the community functions, what it believes, and the ways that it supports different activities. Within the community, individuals support different activities. For example, instructional development is normally accomplished in teams. Team members have negotiated roles based on skills, preferences, or availability. Formal and informal rules evolve to guide their activity. Their assignment to those activities defines the division of labor, which is also mediated by rules and social negotiation (e.g., people in certain departments are responsible for specific activities in the process). Any work community negotiates the rules, customs, and division of labor that mediate its activity. Different communities negotiate different rules and customs.

Because we are all simultaneously members of various communities (the community in which we live, the community within which we recreate, and the professional community in which we work), we must continuously alter our beliefs to adjust to the socially mediated expectations of different groups. Conflicts between our roles in the various communities often arise, leading to transformational activities required to harmonize those contradicting expectations.

Instructional designers also have a role in the contextually important framework of activity theory. They interpret the rules and roles of the community into a series of learning activities in which learners may assume different roles, perform different actions, negotiate different roles, and so on. When analyzing activity systems for the purpose of designing CLEs, then, it is necessary to embed these different aspects of community—the activities and the rules, division of labor, symbolic and social mediators that define those activities.

Historical-Cultural Dimension

Activity is a historically developed phenomenon. That is, activities evolve over time within a culture. In order to understand the dynamics of a particular situation, it is necessary to grasp the changes or evolutions of that situation over time. For example, the ways of "doing instructional design" have changed as new technologies and learning theories evolve and are shared in the instructional design community.

From an activity theory perspective, the process of instructional design or any activity can only be understood by analyzing its historical development. For example, the military orientation of instruction in the '50s and '60s is easily interpretable in view of the fact that most instructional designers worked for the military and accepted its beliefs and values, which in turn permeated the design processes they used. Instructional design skills, like all higher mental functions, are internalized forms of activity that are common to the community in which an individual acts. Activity theory focuses on the centrality of activity in a cultural theory of cognition.

Tool Mediation

Activity always involves artifacts (instruments, signs, procedures, machines, methods, laws, and forms of work organization). While cognitive psychology traditionally has focused only on mental representations, ignoring artifacts or mediating tools and signs, "activity cannot be understood without understanding the role of artifacts in everyday existence, especially the way that artifacts are integrated into social practice" (Nardi, 1996, p. 14). This focus is one that has long been recognized in anthropological research and one that can be useful to instructional designers.

A fundamental assumption of activity theory

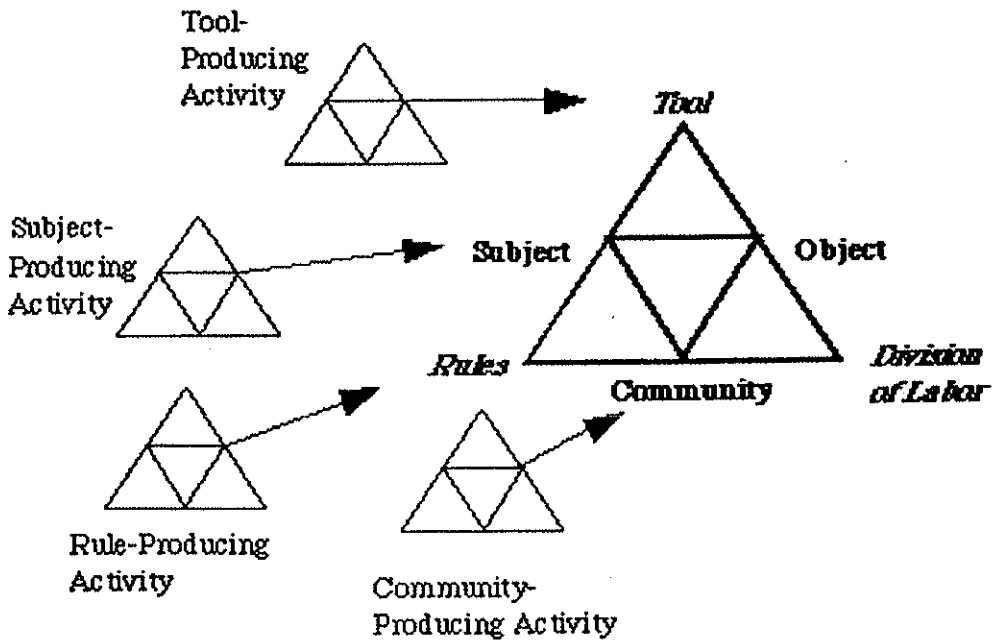
is that tools mediate or alter the nature of human activity and, when internalized, influence humans' mental development. Kaptelinen argues that all "human experience is shaped by the tools and sign systems we use" (1996, p. 10). Just as activity can be understood by comprehending the tools and signs that mediate it, the nature of a tool can be understood only in the context of human activity—by looking at the way that people use it, the needs it serves, and the history of its development. Tools are changed by the ways in which they have been used. In other words, tools are a reflection of their historical development—they change the process and are changed by the process.

Collaboration

Very little, if any, meaningful activity is accomplished individually. People may perform individually in contexts such as school, but their ability to perform is predicated on groups of people. The solo concert pianist, for instance, relies on teachers, the manufacturers of the piano, the designers and builders of the concert hall, and the accompanying conductor and orchestra. So "the human individual's activity is a system of social relations. It does not exist without those social relations" (Leont'ev, 1981, pp. 46–7). Individuals involved in a particular activity are simultaneously members of other activity groups which have different objects, tools, and social relations. However, we naturally are caught up in some of the unrelated activities of our collaborators. Co-workers, for instance, may be engaged in building a house addition or coaching their daughter's soccer team, which engages different activities and cultures. There is a "horizontalness" in activity-theory dynamics. Activities are complex and interactive, which necessitates collaborative effort.

In addition to horizontal activity systems, there are dynamics that underlie ("verticalness") any activity (see Figure 3). Each component of an activity is the result of other activities which produced it. A particular learner group may be the subject of a given instructional activity, yet it may be the result (object) of a particular instructor's assignment to find like-minded people to work with on a project. Engeström (1987),

Figure 3 ☐ Nested nature of activity theory dynamics



described activity as "systems of collaborative human practice."

Summary

Activity theory provides a different lens for analyzing learning processes and outcomes for the purpose of designing instruction. Rather than focusing on knowledge states, it focuses on the activities in which people are engaged, the nature of the tools they use in those activities, the social and contextual relationships among the collaborators in those activities, the goals and intentions of those activities, and the objects or outcomes of those activities. Rather than analyzing knowledge states as detached from these entities, activity theory sees consciousness as the mental activities that suffuse all of these entities. Concepts, rules, and theories that are not associated with activity have no meaning. Articulating each of these entities and their dynamic interrelationships is important when designing instruction, because the richer the context and the more embedded the conscious thought processes are in that context, the more meaning learners will construct both for the activities and the thought processes.

METHOD

If the most appropriate unit of analysis is activity, then CLE designers need to analyze the activity systems for their components and dynamic relations. We next describe a method where activity theory functions as a framework for designing CLEs. The CLE will simulate the activity system in the environment. Although there is not an established methodology for using activity theory to design CLEs, there are numerous precedents for using activity theory as an analytic tool.

Activity theory or components of activity theory have been used to analyze activity in a broad array of domains, including information systems (Nissen, Klein, & Hirschheim, 1991), human computer interactions (Kuutti, 1996), user interface design (Bellamy, 1996; Bødker, 1991b), network communications, education (Engeström & Middleton, 1996), communities of expertise (Engestrom, 1992), decision theory, activities of everyday living (Korvela, 1997; Winegar, 1992), organizational behavior (Engeström, 1987; Koistinen & Kangasoja, 1997) and anthropology-psychology (de Vos, 1986).

Methodological Assumptions of Activity Theory

While activity theory focuses on practice, it is primarily a descriptive tool rather than a prescriptive theory. Care must be taken in generalizing the descriptive lenses of activity theory. While Engeström (1993) believed that activity theory does not offer ready-made techniques and procedures for research, its widespread application as a lens for analyzing activity has yielded some generally accepted practices. First and foremost, whatever the focus, the activity must be studied in real-life practice with researchers as active participants in the process (Kuutti, 1991). Activity theory necessitates a qualitative approach to analysis. In CLEs, it will be necessary to study the in situ practices that you hope to simulate in the learning environment. More importantly, Kuutti recommends that researchers constantly refocus the object of interest in order to provide different views but also to advance the activity as much as possible. In this light, activity research can serve as a kind of formative evaluation where the researcher attempts to improve the outcome of the process.

In order to analyze learning situations, it is important that the analysis assume certain characteristics:

- The research time frame should be long enough to understand the objects of activity, and changes in those objects over time and their relations to objects in other settings. Activities and their objects in groups of workers necessarily overlap. Designers, for instance, may be working simultaneously on different design projects. Compare objects and goals of others with those you are examining.
- Analysts should pay attention first to broad patterns of activity before considering narrow episodic fragments which don't reveal the overall direction and importance of the activity.
- Analysts should use varied data collection

methods (interviews, observations, video, historical materials) and points of view (subject, community, tools). The researcher needs to commit to understanding the activity system from all of these different perspectives.

Before describing the activity analysis methods, we briefly describe the components of a CLE. Later, we describe how the results of the activity analysis are mapped onto the CLE components.

Constructivist Learning Environments

CLEs consist of several interdependent components: a problem-project space, related cases, information resources, cognitive tools, and conversation and collaboration tools (Jonassen, 1999).

Problem-Project Space. The problem-project space captures the activity system that is embedded in a CLE. It must present learners with an interesting, relevant, and engaging ill-structured problem to solve or project to conduct. Problems-projects emerge from real world contexts. What kinds of problems do practitioners solve? Engineers design bridges, circuit boards, airplanes, or processes for reusing chemicals. Philosophers apply ethical principles by rendering judgment on ethical dilemmas, such as right-to-die cases. Problems are everywhere. The problem-project space in CLEs consists of three integrated and highly interrelated components: the problem context, the problem presentation or simulation, and the problem manipulation space.

The physical, sociocultural, and organizational context that surrounds any problem or project helps to constrain and define the problem. In order to define the problem, CLEs must describe all important details of the context in which the problem will be solved, including the physical context, the actors and stakeholders, and the organizational and cultural climate. The context of the problem describes the rules, community, and division of labor components of the activity system.

The problem presentation describes the object of the activity system and replicates the tools, the object, the community, the rules, and division of labor of the activity system. The problem should be authentic and engaging, involving all parts of the activity system. Soon, virtual worlds and environments will be the default for representing phenomena in CLEs. The problem presentation simulates the problem in the context in which it is normally and naturally encountered and provides the challenge for the learners.

The problem or project space must also provide students with the opportunity to manipulate aspects of the problem (the activities in the activity system) in order to allow learners to make it more meaningful. Students cannot assume any ownership of the problem unless they know that they can affect the problem situation in some important way. So, manipulating the phenomena in a problem and seeing the results of those manipulations are important.

Related Cases. Understanding the world requires experiencing it and constructing conscious models of how it functions. The more experiences that you have, the more you learn through relevant activity. Novices lack experience. So, it is necessary that CLEs provide access to a set of related experiences that the student can draw on to represent that deficient experience. Related cases in CLEs support learning by scaffolding memory and by representing complexity.

Related cases enable learners to examine prior experiences and relate them to the current problem. Case reviews should be indexed to the problem that learners are solving to scaffold access to the relevant information.

Related cases also help to represent complexity in learning environments by providing multiple perspectives or approaches to the problems or issues being examined by the learners. An important model for designing learning environments, cognitive flexibility theory, provides multiple representations of content in order to convey the complexity that is inherent in the knowledge domain (Spiro & Jehng, 1991). It stresses the conceptual interrelatedness of ideas and their interconnectedness by providing multiple perspectives or themes that are inherent in cases.

Information Resources. In order to investigate phenomena, learners need information about them. Provide information banks (text documents, graphics, sound resources, video, animations) about the subject that support problem resolution. Information banks need to be organized in ways that support the kinds of thinking that are engaged by the activities. Hypermedia is a useful method for making information accessible in most environments. Providing learners the information they need helps them make meaning when it is provided in a timely manner.

Cognitive Tools. The complexity of CLEs often calls on activities that learners do not possess. In order to scaffold their performance of those activities, designers should identify the skills that are required to solve the problem and build in cognitive tools that help learners to perform those tasks. Cognitive tools replicate the mediation tools in any activity system. They may be visualization tools that enable learners to see phenomena in different ways or tools for representing conscious models of phenomena that are being studied. So, learning environments should also attempt to embed a suite of tools to help learners think in appropriate ways. Cognitive tools include semantic organization, dynamic modeling, information interpretation, knowledge building, and conversational tools (Jonassen, in press). These scaffolds support the learner's exploration, articulation, and reflection in the environment.

Conversation and Collaboration Tools. CLEs use a variety of computer-mediated communication methods to support collaboration among communities of learners. Learning most naturally occurs not in isolation but by teams of people working together to solve problems. Modern learning environments provide access to shared information and shared knowledge-building tools to help them collaboratively to construct socially shared knowledge. CLEs should use computer conferencing, chats, UseNet groups, Multi-User Dungeons (MUDs), and Object-Oriented MUDs (MOOs) to facilitate dialogue and knowledge building among the community of learners.

PROCESS FOR APPLYING ACTIVITY THEORY FOR DESIGNING CLES

In the six steps presented below, we describe how activity theory may be used as a framework for determining the components of the activity system that will be modeled in the components of any CLE. We break each major design step into substeps, and for each substep in the process, we provide sample questions and actions that we would ask to analyze an activity system for the purpose of designing a CLE for the following instructional situation. Following those recommendations in each step, we describe the outcomes of those steps for the following instructional situation.

You have been asked to design a series of CLEs for a graduate executive management program on problems and practices in management. Participants are professionally oriented persons with five to ten years of experience as midlevel managers in corporations. An important component of their success has been their ability to be self-initiators and independent thinkers.

Step One: Clarify purpose of activity system

Engeström (1987) emphasizes clarification of the motives and goals of the activity system. What are participants' goals and motives? What are their expectations about the outcome? The purpose of this step is twofold: (a) to understand the context within which activities occur, and (b) to reach a thorough understanding of the motivations for the activity being modeled and any interpretations of perceived contradictions. For creating CLEs, this step will provide critical information about relevant and appropriate contradictions that can be introduced into the learning environment.

Many techniques might be appropriate at this initial stage, including the analyses of formal and informal documentation, user observations, interviewing, and even psychoanalyses (deVos, 1986). While this step is not always addressed in traditional instructional design, activity theorists believe that it might be the most important step of the process. Given that CLEs are created to instill, encourage and scaffold learning, a

thorough understanding of the intentional dynamics of the activity system is critical. Activities and questions for clarifying the purpose of the activity system are shown in Table 1.

Outcome. The information that is collected in this stage will guide the construction of the problem space. All CLEs are goal-directed, so clearly understanding the goals of the participants represented in the CLE is essential. The goals will define the object of the problem that challenges learners in the CLE. The motives will also determine whose perspectives are important to represent in the related cases. For our scenario, we would examine management problems in several organizations to determine who is involved, what their motives are, and what the expectations are of the problem solver. Those positions will be represented in the problem space as well as the information resources in terms of personnel backgrounds, resumés, mission statements, annual reports, industry standards, and so on.

Step Two: Analyze the Activity System

This step involves defining in depth the components of the given activity, namely, the subject, object, community, rules, and division of labor.

Understanding the subject is essential. The subject of the activity, who is the learner in the CLE, drives the system. The participants establish the goal of the system based on the contradictions they perceive in the system. The analyst must describe how they perceive their roles in relationship to the goals of the system.

The object is the thing to be acted upon, tangible or intangible. Its transformation moves the subject toward the goal. The object will be partially defined by the first step of analysis, but it needs to be explicated. The object may be a product, a communication, a theory, or any combination of elements. Clearly defining how that object will fulfill the goals or intentions of the system is essential.

It is also important to examine the community in which the subjects work, the nature of the social interactions among participants, and the beliefs and values that define or impact the activity. Who are the agents or players in the community of practitioners? Lave and Wenger (1991) claim that learning is the centripetal movement toward the center of a community of practice. The community of practice comprises the activity system. The successful subject (learner) becomes the central character in that community that is represented in the CLE. Depending on the activity, the nature of the community will change, providing the instructional designer with different, and very important, perspectives on what and how the activity should occur. For example, in a traditional classroom-based learning activity, the community might simultaneously be defined as the learners

Table 1 ☐ Applying Activity Theory: Step One

Clarify purpose of activity system.	
1.1 Understand relevant context(s) within which activities occur	Generate a list of problems that executives typically deal with. What participants or groups are involved in the successful completion of the activity? Where and when do those problems normally occur? Prioritize the list. Examine communications that surround the situation or activity.
1.2 Understand the subject, his or her motivations and interpretations of perceived contradictions in the system	Generate a comprehensive list of subject-driven motives and goals for each of the groups involved that might drive the activity. What expectations are there of the performer? Who sets those expectations? Which might contribute to the dynamics of the situation under review? Interview persons directly and peripherally associated with activity to understand contradictions, overall factors that affect activity.

that are coworking on the project, the larger community of the school and school system, and the professional community to which the learners want to belong. Each of these communities has its own set of norms or explicitly or implicitly stated roles for each of its members, and different perspectives on the importance (or lack thereof) of the objective to be accomplished. In describing the activity system, it is also important to examine the division of labor that mediates the relationship between the community and the object. Activities and questions for analyzing the activity system are listed in Table 2.

Outcome. The outcomes of this step will describe all aspects of the problem or project that will be modeled in the CLE. The subject's roles will determine the perspective of the CLE, that is, whose tasks are being assumed by the learner. In this case, the subject would be the manager confronted with a problem. The outcome will also recommend how to represent the problem, the requirements of the problem manipulation space, and the kinds of cognitive tools needed by the learner in order to manipulate the problem. All of the other actors in the activity system need to be identified (who is

Table 2 ☐ Applying Activity Theory: Step Two

Analyze the Activity System	
2.1 Define the subject	Who are the participants in the activity system? What are their roles? What are their beliefs?
	What is the expected outcome of the activity? What criteria will be used by the community to evaluate its utility?
	What are the implied rules or roles for each member of the group?
	What struggles did the group survive in order to reach its current state?
	What are goals-motives of the activity and how are they related to goals-motives of others and society?
	What is the division of labor within the activity system?
	What perceived rewards await the subject if or when it accomplishes its goal?
2.2 Define the relevant community-communities.	To what extent does the subject's work community impact the subject-object pair?
	How mature is the group? How formally are the rules of interaction stated?
	What is the structure of social interactions surrounding the activity?
	How might conflicts that originate in other communities affect participant interactions?
	How do other communities in which participants are involved view this task? Do they value the goals of the activity?
	What perceived rewards await the subject if or when it accomplishes its goal?
2.3 Define the object	What is the expected outcome of the activity? Is the end product a presentation, a report, a theory or a combination of these (or other) elements?
	What criteria will be used to evaluate the quality of the outcome? Its viability?
	Who will apply the specified criteria? How much credibility does that individual or group have with participants?
	How will completing the object move the participant toward fulfilling the intentions of the individuals? Of the program?

causing the problem, bosses, human resources department support staff, anyone who may be related to the case). The relationships among the actors will be represented later by hyperlinks between the actors. The object represents the goal of the CLE, that is, what represents an appropriate and adequate problem solution. That will, of course, depend on the nature of the problem, however the object will normally be the resolution of the problem by dealing with employees, reengineering the setting, or changing incentives. It will also identify the contextual elements that need to be identified and indexed in related cases, worked examples and problem situations given. The community and its rules determine the problem context, and the division of labor determines with whom the learner must interact while manipulating the problem. These also recommend perspectives in the related cases and information about their roles and perspectives that must be represented in the information resources. The tools are analyzed in Step Four.

Step Three: Analyze the Activity Structure

Another key process is analyzing the activity structure (all of the activities that engage the subject) that defines the purpose of the activity system. Activities consist of individual and cooperative actions and chains of operations. This hierarchy of activity, actions, and operations describes the activity structure

The activity level has been interpreted as the intentional level because it focuses on the intentions or motives (conscious needs, values, desires) as its driving force(s) (Linnard, 1995). Examples of activities relevant to this management problem include developing training programs, aggregate planning, and counseling employees. From these examples it is evident that activities are complex. This perspective describes the goal of the system.

The action level is the functional level (Linnard, 1995) that uses planning and problem solving actions to fulfill the activities. Examples of actions include conducting needs analysis and designing presentations for the training activity; predicting demand, setting marketing agendas, and anticipating staff needs for aggregate planning activity; and selecting a therapeutic approach, establishing a career placement service, and resolving conflicts for the counseling activity. The same activity may be realized by different actions, depending on the situation. Conversely, the same actions can belong to different activities (Kuutti, 1996). According to activity theory, actions cannot be understood without the frame of reference created by the surrounding activity, which goes back to the argument of the importance of fully understanding the context within which activities occur. Actions, too, are complex, and can be further divided into chains of operations.

Operations are automatized or routinized behaviors. Subjects conduct operations in order to complete the conscious actions, meaning that most operations do not require conscious intentions. Examples of operations include tabulating surveys and drawing graphics for the training activity; averaging sales and reviewing applications for the aggregate planning activity; and greeting clients and exchanging small talk for the counseling activity. There is a dynamic relationship between actions and operations. Initially, operations are conscious actions with both orientation and execution phases. Over time, the orientation phase is eliminated, and action collapses into an operation. At some time, a newer, broader action will form with this newly formed operation as a subpart.

Together, these three levels (activity, action, operation) comprise an activity structure. Activity structures describe the interrelationships of all of the conscious and unconscious thinking and performances focused on the object (e.g., the house, the software, or the course). By extension, therefore, activity defines CLEs because CLEs focus on an activity. So for any activity, it is necessary to identify all of the actions and operations that support the activity.

This is not unlike the traditional needs and task analysis phases of instructional design. Defining and identifying activity structures, however, suggest purposely including an understanding of the intentionality of the action or operation for the learner. Why are people doing this? Further, it situates these actions and operations in contexts that are both external and

internal (interpreted) to the individual. This decomposition of activities into its supporting actions and operations creates the depth necessary for the design of good CLEs. Activities and questions for analyzing the activity structure are listed in Table 3.

Outcome. The outcomes of this stage of any activity analysis will be a description of the activities, actions, and operations that are required to solve the problem in the CLE. The activity structure defines the problem manipulation space; that is, how will learners in the CLE be able to manipulate the object being simulated in the CLE? This process should be repeated in different contexts. For our scenario, you would want to analyze and represent in the CLE management problems in 6–10 different settings. In order to understand the social roles and cultural context (discussed later) that surrounds the activity, you would need to see how managers work in these different settings. Analyzing different activities provides the basis for the problem manipulation space for 3–5 of the problems and a set of 5–7 related cases (examples of activities with similar activity structures). the actions available to the manager need to be added to the problem manipulation space. In the problem manipulation space, you need to define what actions the manager can take. For each, what will be the result? Additionally, the activity structures will isolate the actions and operations that may need to be modeled or scaffolded in the learning environment.

Step Four: Analyze Tools and Mediators

The components of the activity system (subject, community, object) do not act on each other directly. Instead, their interactions are mediated by signs and tools, which provide the direct and indirect communication between the objects. Analyses of mediators and their transformation over time also provide important historical information about how and why activity systems exist as they do. In other words, it is important to examine the role that persistent structures, such as artifacts, institutions, and cul-

Table 3 ☐ Applying Activity Theory: Step 3

Analyze the activity structure	
3.1 Define the activity itself	How is work being done in practice? Identify the activities in which subjects participate. How has the work (actions and operations) been transformed over time? What historical phases have there been on the work activity? What was the nature of the changes that occurred in different historical phases? What norms, rules, and procedures in the actions and operations have been documented? What forms of thought, "rationality types," or theoretical foundations have dominated the work and how have they changed? What do the workers think about them? What are goals-motives of the activity and how are they related to other concurrent goals? What are the contradictions, as perceived from the standpoints of all relevant subjects that drive this activity?
3.2 Decompose the activity into its component actions and operations	For each activity, observe and analyze the actions that are performed and by whom. Examples may include problem isolation, calling and managing meetings, developing operational plans, etc. For each action, observe and analyze the operations that subjects perform. Examples of operation include: note taking, calling on the telephone, sending messages, or setting up routine equipment.

tural values, play in shaping activity. Recall that mediators can be instruments, signs, procedures, machines, methods, languages, formalisms, and laws: forms of work organization.

The most common conception of mediators is tools. Leont'ev (1974) believed that tools mediate activity that connects a person not only with the world of objects but also with other people. Those tools distribute thinking, problem solving, or other mental actions between the tool and the user (Nardi & Miller, 1991). That is, some of the cognitive responsibility is off-loaded to the machine. When the computational or physical actions that tools perform better are off-loaded to the tool, the user plus the tool are more effective (Perkins, 1993).

Today, the most common form of tool in learning environments is the computer. Information technology can serve as a tool in manipulative and transformative actions directed to an object (symbol manipulation tools). A computer can be the principle enabler for an activity; it can make activity feasible and possible (by networking or linking) (Kuutti, 1996). Computers may also enable an activity to have an object that would have otherwise been impossible to grasp. According to Leont'ev (1978), in principle, all operations can be automated. So, the use of cognitive computer tools to supplant some or all operations in an activity in order to off-load cognitive responsibility will more intensely focus consciousness on actions and activities.

Mediators also assume the usage of formal rules or models. Rules mediate the relationship between the subject and the community or communities in which they participate. The models, procedures, or methods that are culturally accepted in any context can also mediate activity. In instructional design contexts, for instance, certain models for design or methods for conducting needs assessments provide cultural norms. At the Institute for Learning Sciences, goal-based scenarios dominate the design process. A set of case-based reasoning methods is commonly used for representing intelligence for the purpose of rendering context-specific advice. These methods and formalisms clearly mediate the CLE design process there. Activities and questions for analyzing the tools and mediators are listed in Table 4.

Outcome. The tools and mediators primarily describe the kinds of models and methods that constrain activity. Those will be reflected in the problem manipulation space as well as the information resources. For instance, settling an employee problem in a union shop will require a description of the labor agreement, protocols for interacting with union employees, and so on. Second, mediators are needed to describe the problem manipulation space, specifically the kinds of mediators that are used to manipulate objects in that space. How can employees be contacted and treated? Do they need a representative present? This step will also provide recommendations about the kinds and formats of information resources that need to be included in a CLE. This might include appropriate background readings or information about theories, models, and methods when dealing with unions. The collaboration tools that will be necessary depends on the allowable interactions among different actors in each of the settings.

Step Five: Analyzing the Context

The issue that activity theory addresses most directly and that is perhaps most relevant to the design of CLEs is contextuality. Traditional methods of task analysis focus only on the technical core of performances, ignoring the real-life, noninstructional contexts within which activities occur. Activity theory argues that decontextualized performance produces little if any understanding. Activity itself is both defined by and defines context. Context is not merely the outer container in which people behave in certain ways. Rather, people consciously create context through their own objects. Context is both internal to people (involving specific objects or goals) and external (involving artifacts, other people, and settings).

Analyzing context is essential for defining the larger activity systems within which activity occurs (subject, community, object) and the dynamics that exist within and between the subject and the mediators. The designer is seeking information in order to describe "how things get done in this context." Why? Because different contexts impose distinctively different practices.

Table 4 ☐ Applying Activity Theory: Step Four

Analyze Mediators	
4.1 Tool mediators and mediation	What tools might be used in this activity? How readily available are those tools to participants? What are the physical (instruments, machines) and cognitive (signs, procedures, methods, languages, formalisms, laws) tools used to perform activities in different settings and across activities (projects)? How have the tools changed over time? What models, theories, or standardized methods will guide this activity? How might participants use these? Is their use flexible, or is adherence required?
4.2 Rule mediators and mediation	What formal or informal rules, laws, or assumptions guide the activities in which people engage? How might these rules have evolved (formal-informal, internal-external)? Are they task-specific? How widely understood are these rules?
4.3 Role mediators and mediation	Who traditionally has assumed the various roles? How does that affect work group assignments or breakouts? How do these roles relate to the individual's nonacademic experiences? What forces drive the role changes? How much freedom will individuals have to force others to take on new or different roles within the work group?

Table 5 ☐ Applying Activity Theory: Step Five

Analyze the context	
5.1 Internal or subject-driven contextual bounds	What are the beliefs, assumptions, models, and methods that are commonly held by working groups? How do individuals refer to their experiences in other work groups? What type of language do they use? What tools did they find (un)helpful in completing those projects? How willing are they to use them again? To try new tools in similar contexts?
5.2 External or community-driven contextual bounds	How much freedom do individuals have about entering a work group? What is the structure of the social interactions surrounding the activity? What activities will be considered to be critical (i.e., assessed, measured, or graded)? What type of limitation will be placed on this activity by the company or outside agencies? How are the tasks organized among the members of the aggregate who are working toward the object? Will these structures be dictated or allowed to emerge from within each group? How are tasks divided or shared among participants? Who does what? How flexible is the division of labor? How will these roles and their contribution be evaluated (by evaluator or participants)? Is there a difference between the implied rules-roles for each member of the group and those that are formally stated? What formal or informal rules, laws, or assumptions guide the activities in which people engage? To what degree will the groups be expected to explicitly state those?

Activities and questions for analyzing the context are listed in Table 5.

Outcome. The outcomes of these actions will describe the problem context that is modeled in the CLE. The community of actors needs to be identified and invested with capabilities, restrictions, actions, privileges, and so on. Those attributes need to be the basis for connecting the actors and their relationships in the CLE (described in the next step). What social relations and division of labor should be represented in the problem context? These features make the environment ill structured, complex, and (most importantly) relevant and meaningful to learners. Analyzing the activity context will also identify the contextual elements that need to be identified and indexed in the related cases in order to help learners access them. What tools and mediators are used by managers? Case access or moving between cases or problems is often based on similarity of contextual elements. Finally, analyzing the context will make obvious the kinds of conversation and collaboration tools that are required to support the activity structure. What kinds of interactions are the managers allowed with other employees, outside contractors, attorneys, or others? How do they normally communicate with each of these people? What are the communication protocols?

Step Six: Analyzing Activity System Dynamics

The final stage of activity analysis requires stepping back from the system that you have described and assessing how components affect each other. This process provides a final reality check of the system. Activities and questions for analyzing the activity system dynamics are listed in Table 6.

Outcome. This is the step where you link the components of the CLE. Make sure that relations among members of work groups and the mediators they use are hyperlinked together. That is, the different parts of the problem space need to be interconnected. The problem manipulation space needs to be connected to work group members and the cognitive tools needed to perform the task. The problem representation needs to be connected to the related cases and information resources. The collaborative tools need to interconnect the members of the learning community who are working on the CLE. After interconnecting all of the components, the sys-

Table 6 ☐ Applying Activity Theory: Step Six

Analyze Activity System Dynamics	
6.1 What are the interrelationships that exist within the components of the system?	What are the dynamics that exist between the components of the activity system? How formal-informal are the relationships described? Are there contradictions or inconsistencies within the needs of this population and the goals of these learning activities? How do the individuals perceive these goals, particularly vis-à-vis their own successes and their perceptions of what has led to those successes?
6.2 How formally established are those relationships?	How formally will the relationships between members be determined? What are the drivers of change? How lasting and permanent are these changes? How accepted are those relationships perceived within the framework of the larger graduate school culture?
6.3 How have those interrelationships changed over time?	What factors have driven the formation of work groups within this population in the past? How lasting and permanent have these groups been in the past? What factors kept those groups together or drove those groups apart?

tem functionality should be tested to determine if other resources are needed. A final check of the system needs to be run prior to user testing.

CONCLUSIONS

This article has described a theory of activity-based learning (activity theory) that may be used as a framework for describing the components and their interrelationships in CLEs. "Activity theory seems the richest framework for studies of context in its comprehensiveness and engagement with different issues of consciousness, intentionality, and history" (Nardi, 1996, p. 96). Applying activity theory to analyzing real-world situations for the purpose of designing CLEs involves examining and elaborating several factors: the activity structures engaged by work; the tools, rules, and symbol systems that mediate that work; and the social and conceptual context in which that work occurs. Experience in applying these methods for activity system analysis is needed for validation. □

David Jonassen is Professor of Instructional Systems at The Pennsylvania State University. His current research focuses on designing constructivist learning environments, cognitive tools for learning, knowledge representation methods, problem solving, computer-supported collaborative argumentation, cognitive task analysis, and individual differences and learning.

Lucia Rohrer-Murphy is a doctoral student in Instructional Systems at The Pennsylvania State University. Her research interests include activity theory and structural knowledge.

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