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AN ECOLOGICAL PSYCHOLOGY OF INSTRUCTIONAL DESIGN: LEARNING AND THINKING BY PERCEIVING–ACTING SYSTEMS

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7.1 INTRODUCTION

The word "ecological" in the title might bring to mind for the reader visions of plants and animals evolving to fill an environmental "niche," ecosystems changing too quickly creating endangered species or vanishing rainforests, or the complex climate systems for which advanced mathematical models have only limited success in predicting such things as hurricanes, ocean currents, global warming, climate changes, and daily weather. Perhaps surprisingly, these are the very issues that are relevant to instructional design. Much of what has been explored and defined for physico-chemo-biologic feedback systems has meaning when considering how people interact with learning environments, creating psycho-physico-chemo-biologic learning systems.

Ecological psychology finds its roots in the philosophy of rationalism (relying on reason rather than intuition, introspection, or gods) and empiricism (learning about the world through perception, not inborn understandings) and draws on models from physics and biology rather than information processing theory or traditional computer science. It presumes that learners have a basic "comportment" to explore their world and learn from their senses (Heidegger (1927a, 1927b), and prefers an integrated agent–environment view of learners as "embodied and embedded" in everyday cognition (Merleau-Ponty, 1962). Ecological psychology grew from Gibson's (1986) seminal description of how vision is the result of direct perception, rather than the reconstruction of meaning from lower-level detection of energy properties and complex geometrical processing. The ecological approach is often cited as the basis for a "situated cognition" approach to thinking and learning (e.g., Brown, Collins, & Duguid, 1989; CTGV, 1990, 1993; Greeno, 1994, 1998; Young, 1993) and relates to these and similar trends in contemporary educational psychology. There are current trends in computer science that have similar origins and address related issues, including the programming of autonomous agents and robots, autonomous living machines, and evolutionary computing, to name just a few. And there are also related issues across domains, particularly efforts that seek to integrate brain, body, and the lived-in world into a reciprocal codetermined system (e.g., Capra, 1996; Clark, 1997; Coulter, 1989; Sun, 2002; Vicente, 1999).

The emerging mathematics for an ecological description of cognition takes as its starting point the nonlinear dynamics of complex systems. For example, the "chaos" models used to predict the weather can be meaningfully applied as a metaphor to learners as autocatakinetic learning systems (Barab, Cherkes-Julkowski, Swenson, Garrett, Shaw & Young, 1999). Such theories of self-organizing systems rely on the presumption that higher degrees of complexity are more efficient at dissipating energy given an ongoing source of energy input (so-called open systems). Biological systems are such systems in that they take in energy from the environment (e.g., photosynthesis) or produce energy internally themselves (by eating and digesting). But a full analysis of the thinking and learning aspects of agent–environment interactions requires the modeling of an "information field" along with the energy fields and gradients that define the world (Shaw & Turvey, 1999). Such an information field is required to explain behavior in all forms of intentionally driven agents, slime molds, dragonflies, and humans alike.

With this as the contextual background, this chapter seeks to introduce the key ideas of ecological psychology that apply to instructional design. In addition to introducing these key concepts, a few examples of the reinterpretation of educational variables are given to illustrate how an ecological psychology approach leads to differences in conceptualizing learning environments, interactions among learners, and the related issues of instructional design.

7.2 THE BASICS

While much of the field of education in general, and the field of instructional design specifically, is controversial and not governed by absolute and generally accepted laws or even working principles, there are some things on which most educators would agree:

- Learners are self-directed by personal goals and intentions
- Learning improves with practice
- Learning improves with feedback

Considering these three time-honored educational principles for a moment, learners' goals and intentions are a part of nearly all learner-centered instructional designs. For example, the APA (1995) has endorsed 14 principles of optimal learning that take student-centered learning as fundamental. Similarly, whether from behavioral or information processing perspectives, practice is a powerful instructional variable. And likewise, one would be hard-pressed to find an instructional designer who did not acknowledge the essential role of feedback, from simple knowledge-of-result, to elaborated individualized or artificially intelligent tutoring systems' custom interactions. Perhaps reassuringly, these three are also basic principles that are fundamental to an ecological psychology perspective on learning and thinking.

Although, because of its emphasis on the role of the environment, at first blush one might want to equate an ecological approach to cognition with behaviorism, a fundamental distinction rests in ecological psychology's presumption of intentionality driving behavior on the part of the learner. While behaviorism in its purest form would have the environment selecting all the behaviors of the learner (operant conditioning), an ecological psychology description of behavior begins with the definition of a "goal space" or "Omega cell" (Shaw & Kinsella-Shaw, 1988) that consists of a theoretical set of paths that define a trajectory from the current state of the learner to some future goal state selected by the learner. In this way, the goals and intentions of the learner are given primacy over the interaction between environment and learner that subsequently arises. Perhaps the only additional constraint imposed by ecological psychology on this fundamental presumption is that goals and intentions are typically visible, attainable goals that have concrete meaning or functional value to the individual. While this does not eliminate lofty abstract goals as potential sources for initiating behavior, it represents a sort of bias toward the realistic and the functional.

The second basic principle of learning, repeated trials, or practice, is an essential element of many of the basic perceptual–motor behaviors that serve as the basis for extending ecological psychology to instructional design. Things that people do in everyday life present many opportunities to "see" (perceive and act on) how the environment changes across repeated trials as they walk, crawl, step, catch, etc. Some fundamental studies include Lee's (1976) description of grasping, time-to-collision (tau), and optic flow as well as other midlevel intentional behaviors such as the perception of crawlable surfaces (Gibson, 1986), sittable heights (Mark, Balliett, Craver, Douglas, & Fox, 1990), steppable heights (Pufall & Dunbar, 1992; Warren, 1984), passable apertures (Warren & Wang, 1987), center of mass and center of percussion (Kugler & Turvey, 1987), and time to contact (Kim, Turvey, & Carello, 1993; Lee, Young, Reddish, Lough, & Clayton, 1983). In all these cases, it is experience with the environment across repeated trials (steps, tosses, grabs) than enable an agent to tune their attention to significant "invariants" across trials.

The third basic principle of learning, feedback, is one of the elements that has been mathematically modeled using principles of ecological psychology. Shaw, Kadar, Sim, & Repperger (1992) constructed a mathematical description for a hypothetical "intentional spring" situation showing how learning can occur through direct perception with feedback, without need for memory, storage, or retrieval processes. In a system that provides feedback by coupling the perceiving–acting of a trainer with the perceiving–acting of a learner (a dual of duals), the action and control parameters of the trainer can be passed to the learning (the coupled equations solved to identity) through repeated trials. These three principles, intentionality, practice, and feedback, are the basics on which a further description of an ecological psychology approach to instructional design can be described.

7.3 ECOLOGICAL TENETS

Perhaps the favorite metaphor for thinking about learners in traditional cognitive psychology is that they are like computers, taking in, storing, and retrieving information from temporary and long-term storage (memory)—the information processing model of learning. This model is presumed to explain all of human behavior including thinking and learning (e.g., Cognitive Science, 1993). While this model has produced a substantial body of research on rote memorization, semantic networks of spreading activation, and descriptions of expert–novice differences, attempts to take it further to create machines that learn, robots that move about autonomously, systems that can teach, and programs that can solve real-world problems have been difficult or impossible to achieve (e.g, Clancey, 1997; Clark, 1997). It seems that to some extent, computers work one way and people work another.

7.3.1 Ecological Psychology Posits an Alternative Metaphor Concerning How People Think and Learn: Learner as Detector of Information

This approach takes as fundamental the interaction of agent and environment. Rather than explain things as all inside the head of the learner, explanations emerge from learner–environment interactions that are whole-body embedded in the lived-in world experiences. Thermostats, rather than computers, might be the preferred metaphor. Thermostats represent a very simple form of detectors that can sense (perceive) only one type of information, heat, and can take only one simple action (turning the furnace on or off). But even such a simple detector provides a richer metaphor for learning than the computer storage/representation/processing/retrieval metaphor. The thermostat is a control device with a goal (the set point). It interacts continuously with the environment (ambient temperature), dynamically perceiving and acting (if you will) to detect changes in the temperature and to act accordingly. For our purposes, the most critical attributes of this metaphor are that interaction is dynamic and continuous, not static or linear, and the perceiving–acting cycle unfolds as a coupled feedback loop with control parameters and action parameters.

People, of course, are much more sophisticated and intentionally driven detectors, and they detect a wide range of information from their environment, not just temperature (which they can, of course, do through their skin). What this means is that rather than detect purely physically defined variables, people detect functionally defined informational-specified stable (invariant) properties of their world. Visual perception is the most studied and best understood perceptual system from the perspective of ecological psychology. Using vision as an example, rather than detecting the speed or velocity of an oncoming pie, people detect time-to-contact directly from the expansion rate of the image on their retinas (see Kim et al., 1993, for details). Thus the functional value here is not speed or velocity, it is time-to-pie-in-the-face, and once detected, this information enables avoidance action to be taken directly (ducking as needed).

In describing the functional value of things in the environment, Gibson (1986) coined the term "affordances," stating, "the *affordances* of the environment are what it *offers* the animal, what it *provides* or *furnishes,* either for good or ill" (p. 127). Affordances can be thought of as possibilities for action. Affordances are detected by a goal-driven agent as they move about in an "information field" that results from the working of their senses in concert with their body movements. As the agent moves, regularities within the information field emerge, invariants, that specify qualitative regions of functional significance to be detected. But affordances themselves cannot be thought of as simply stable properties of the environment that exist for all agents and for all times. Instead, the agent's skills and abilities to act, called "effectivities," codetermine the affordances. Such "duals," or terms that codefine each other are sometimes difficult to describe.

Consider that doorknobs have the affordance "turnable," lakes have the affordance "swimmable," onscreen buttons have the affordance "clickable," flower leaves have the affordance "landable," and open doorways have the affordance "passable." However, these affordances only exist for certain classes of agents and would only display high attensity (as defined in Shaw, McIntyre, & Mace, 1974) related to their functional value in situations where certain intentions arise. For example, doorknobs are turnable for human adults, but not for paraplegics (unaided by assistive technology) or young infants. Lakes are swimmable for ducks and for people who know how to swim, but not for bees or nonswimmers. Screen buttons are clickable if you know how to use a mouse or touchpad, but that affordance may not exist for immobilized users. For a dragonfly flying at 20 mph, a small flower leaf affords landing, but the small leaf does not have the same affordance for a human, who lacks the landing effectivity and can't even fly at 20 mph then land on any leaf. And doorways may have the affordance passable for walking adults, but that affordance may not exist for wheelchair users. Further, consider that until the related intention emerges, the functional value of these affordances can only be presumed; that is, affordances cannot be fully described until the moment of a particular occasion. Shaw and Turvey (1999) summarized this intentionally dynamic codeterminism of affordances and effectivities by stating that affordances propose while effectivities dispose. So to define an affordance, one must presume a related goal as a given, and must simultaneously codefine the related effectivities.

With the perceiving–acting cycle as a given, **action** (particularly moving one's body in space, but allowing for other more cognitive actions as well) **is an essential part of an ecological psychology description of thinking**. Thus an explanation of thinking is more a whole-body activity in context than simply an in-the-head process. Consider a classic example of thinking as "enacted" from Lave's (1988) description of a Weight Watchers member preparing cottage cheese as part of his lunch:

> In this case [the Weight Watchers] were to fix a serving of cottage cheese, supposing that the amount allotted for the meal was three-quarters of the two-thirds cup the program allowed. The problem solver in this example began the task muttering that he had taken a calculus course in college (an acknowledgment of the discrepancy between school math prescriptions for practice and his present circumstances). . . . He filled a measuring cup two-thirds full of cottage cheese, dumped it out on a cutting board, patted it into a circle, marked a cross on it, scooped away one quadrant, and served the rest. Thus, "take three-quarters of two-thirds of a cup of cottage cheese" was not just the problem statement but also the solution to the problem and the procedure for solving it. The setting was part of the calculating process and the solution was simply the problem statement, enacted with the setting. (p. 165)

This exemplifies how perception is always *FOR* something, that activity drives perception which drives action, and from the ecological psychology perspective, activity is taken to be an inevitable part of thinking.

Lave's Weight Watcher is a beautiful example of how thinking, in this case problem solving, emerges from the interactions of the perceiving–acting cycle. But it also illustrates the dynamics of intentionality, as new goals and intentions emerge in situ.

The Weight Watcher did not begin his day with the goal to quarter and scoop cottage cheese. Rather, through interaction with the Weight Watchers instructors in the context of this exercise, he was induced to have the goal of apportioning the two-thirds cup daily allocation mostly for lunch and leaving a quarter for dinner. **The process of inducing students to adopt new goals is an essential element of instructional design from the ecological psychology perspective.** Further, as he proceeded to begin the task, the dumping and quartering procedure created the intention to scoop out a quarter. This new intention organized the perceiving–acting cycle for grasping a spoon and for the ballistic movements associated with scooping. In this way, the emergence of new intentions (dynamics of intentions) that drive the perceiving–acting cycle can be described.

The dynamics of intentions requires us to posit that intentions organize behaviors on multiple space–time scales (Kulikowich & Young, 2001). So a person can be pursuing multiple goals at once. Consider that as you read this paragraph, you may have several goals organizing your behavior. You may be enrolled in school to be a good provider in the role of wife, father, son, or daughter. You may be pursuing career goals. You may be in a class hoping for an A grade. But you may also be getting hungry or you may need to complete some personal errands. Some of these goals are organized in hierarchically nested space–time scales so they can be simultaneously pursued. Others, such as reducing hunger by getting up and making a snack, necessarily compete with the goal of reading this chapter. Given the premise that goals and intentions organize behavior, ecological psychology has proposed a cascading hierarchy of constraints that, at the bottom, end in the moment of a specific occasion on which a particular goal creates a goal path (Omega cell) that organizes behavior allowing the perceiving–acting cycle to unfold. But of course the dynamics of intentions must also allow for interruptions or new goals to emerge (like compactified fields), springing up in the middle of the pursuit of other goals. The cascade of hierarchically organized constraints has been described as "ontological descent" and is specified in more detail elsewhere (Kulikowich & Young, 2001; Young, DePalma, & Garrett, 2002). Understanding the nature of goals as organizers of behavior is a substantial part of guiding instructional design from an ecological psychology perspective.

7.3.2 The Bottom Line: Learning = Education of Intention and Attention

Any theory of instructional design must define what it means to learn. Behavioral theories define learning simply as the development of associations. Information processing theories also provide an in-the-head explanation of learning but prefer a memory-based storage and retrieval model in which things internally stored in short-term memory are encoded into long-term memory and rules are compiled through practice into automatic procedures. But ecological psychology raises questions about how such compiled procedures can be so elegantly and seemingly directly played out given the many changes in our contextual environment. For example, how can skilled drivers drive almost mindlessly to work, talking and thinking about other things while engaged in such a skilled performance? Such questions suggest that something other than the simple playing out of compiled scripts may be at work. Ecological psychology looks for an answer in the direct perception of agent-environment interactions. Maybe such procedures are not stored in memory at all, but rather, the environment provides enough information so perception and action can proceed directly, without the need for retrieval and other representational cognitive processing.

With this thought in mind, consider the ecological psychology alternative:**learning is defined as the education of intention and attention**. The education of *intention* was described above, stating that new intentions can be induced through experiences with other people or they can emerge as compactified fields during the pursuit of existing goals. Consider that the many TV ads you encounter while pursuing the goal of watching your favorite show have as their primary mission to induce in you some new goals associated with the need to purchase the targeted product or service. The additional part of the definition, then, is the education of *attention*. Like the thermostats mentioned above, people can be "tuned" to detect information in the environment that they might not initially notice. Such "attunement" can take place through direct instruction, as a more knowledgeable person acts together with a more novice perceiver (scaffolding). A mathematical model of such a coupled two-person system has been described as the "intentional spring" model (see Shaw et al., 1992; Young, Barab, & Garrett, 2000).

Experience can also attune peoples' attention to aspects of their environment that have functional value for their purposes. As the perceiving–acting cycle unfolds, the environmental consequences of actions produce new experiences that can draw the attention of the perceiver to new affordances of the environment. This could also happen vicariously, as one student perceives another student operating within a shared environment. The actions of one student, then, can cause another to detect an affordance, enabling the perceiver to achieve a goal and "tuning" them to be able to detect similar functional values in the environment in the future. The resultant tuning of attention, along with the induction of new goals, represent the education of attention and intention that define learning.

Learning as the tuning of attention and intention is a differentiation process rather than a building up of associations as is classically the definition of learning from an information processing perception. This has implications for instructional design, in that the tools, activities, and instruction that are designed are not viewed as adding into the accumulating data in the heads of students. Such an information processing assertion is based on an assumption that perceptions are bare and meaningless until interpreted and analyzed by stored schemas. In contrast, an ecological presumption is that a sensitive exploring agent can pick up the affordance of an environment directly through exploration, discovery, and differentiation (Gibson & Spelk, 1983). So the learning environment and associated tool, activities, and instruction that are designed for instruction should serve to highlight important distinctions and focus the students' attention on previously unnoticed uses for things in the world.

7.4 REINTERPRETATIONS OF KEY LEARNING SYSTEM VARIABLES

7.4.1 Collaboration

Drawing from biology, as ecological psychology is prone to do, there is precedence for describing how isolated individuals can be drawn together to adopt a shared intentionality in the life cycle of *Dictyostelium discoideum* (Cardillo, 2001). *D. discoideum,* a type of slime mold, typically exists as a single-celled organism, called a myxamoeba. However, when food sources become scarce, the individual myxamoebae form a collective organism called a pseudoplasmodium, as seen in Fig. 7.1. This collective has the effectivity to move via protoplasmic streaming and, thus, is capable of responding to energy gradients in the environment in order to slither to better food sources—a capability well beyond that of any individual myxamoeba alone (Clark, 1997).

D. discoideum has a different set of effectivities as a myxamoebae than it does as a pseudoplasmodium. When the set of effectivities of the pseudoplasmodium, considering its current intentions (goals), becomes more appropriate to the environment at hand, individual myxameobae reconfigure to act collectively in order to more effectively cope with their environment. The collective behavior of learning groups may be similarly described.

By analogy, ecological psychology enables the description of groups of students using the same affordance/effectivity and perceiving/acting terms as applied to individuals (DePalma, 2001). The collaborative, intention-sharing group, becomes the unit of analysis. Analysis at the level of the collective forces the externalization, and subsequent observability, of aspects of intentionality that are not observable in an isolated agent and are thus a property of a higher order organization of behavior. Preliminary results from describing collaboration in these terms suggests that all definitions, metaphors, comparisons, and other instances of the ecological agent are applicable to the collective. Learning groups, termed "collectives" to highlight their shared intentionality, are described as perceiving–acting wholes, with goals and intentions organizing their collective behavior.

7.4.2 Motivation

Ecological psychology has suggested that motivation may not be the all-explaining educational variable it is often proposed to be. Preliminary research into the motivation and interest of hypertext readers, using principles of ecological psychology, suggest that any stable description of "motivation" may be related to the stabilities of goals and intentions and affordances of environments (Young, Guan, Toman, DePalma, & Znamenskaia, 2000). Evidence suggests that both interest and motivation, as rated by the participant, change moment to moment, with the degree to which particular screens of information afford progress toward the reader's goal. This suggests the colloquial understanding of motivation may simply be an epiphenonmenon, the result of presuming such a variable exists and asking people to rate how much of it they have. Rather than being a relatively stable internal cognitive force that drives and sustains behavior (e.g., Ford, 1992), motivation is reinterpreted as an on-going momentary personal assessment of the match between the adopted goals for this occasion and the affordances of the environment. High motivation, then, would result from either adopting goals that are afforded by the present learning context or finding a learning context that affords progress toward one's adopted goals.

For instructional designers this means developing contexts that induce students to adopt goals that will be afforded by the learning contexts they design, especially one that enables students to detect the raison d'être of the material (Young & Barab, 1999). Likewise for students, the implications are that an honest assessment by the student of current goals will specify the level of motivation. Students whose goals are "to please the teacher," "to complete the course," or "to get an A" will be perceiving and acting to detect how the current context can further these goals. Consider two examples. A student who enrolls in a statistics course whose job is in qualitative market research. Such a student may not at first see the affordances of a quantitative approach to data reduction, but during the course may begin to see how the statistical analyses could move her forward to achive job-related goals. Similarly, consider a K–12 classroom teacher who comes back to school for ongoing

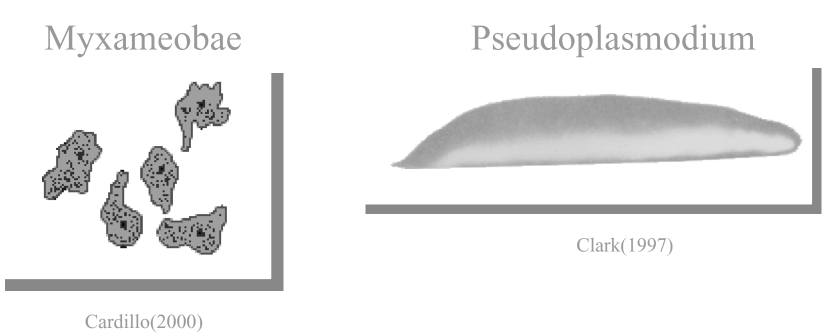

FIGURE 7.1. Organization of *D. discoideum* from individual myxameobae into a pseudoplasmodium for collective action.

inservice professional development in an educational technology course, thinking it will fulfill a school district requirement, but then detects how the technology he learns about can be applied to his existing lessons. Given learners with these goals rather than learning goals to master the content of instructional materials, instructional designers should not be surprised when the actions students take in a designed learning context appear unanticipated from the perspectives of the original designers.

7.4.3 Problem Solving

Ecological psychology principles have been used to describe the problem solving that takes place in the context of anchored instruction (CTGV, 1990, 1993). Young, Barab, and Garrett (2000) described a model of problem solving that presumes various phases of agent–environment interactions taking place as problem solvers view then work on the video-based problems. Viewers first detect information in the video presentation of the problem, then to a greater or lesser extent, adopt the goal of solving the problem (note some students may have the goal to get the right answer and display their mathematics prowess while others may have more genuine intentions to help the story protagonist solve a fictional dilemma). Perceiving and acting on the values using valid mathematical calculations then proceed until a solution is deemed to be reached (this must be seen as "enacted" activity in situ as described by Lave, 1988 above). All along the way, this model describes events as interactions between intention-driven learners and information-rich video environments.

This description of mathematical problem solving contrasts with that of information processing views. Rather than describing rules and procedures as stored inside the learner, this description focuses on activity in situ, describing it as behavior arising on a particular occasion the results from a cascade of environmental constraints imposed by contextual circumstances and personal goals. Understanding the goals that are actually organizing a student's behavior is a difficult task. Students cannot often just articulate their goals when asked. However, it seems no more difficult than speculating about the compiled rules and procedures that are stored in someone's memory. Both must be inferred from quantitative and qualitative assessment of what the problem solvers say and do, particularly the choices they make that may be evident when completing their problem solving with the aid of a computer.

7.4.4 "Flow," a Description of Optimal Performance

Csikszentmihalyi (1990) described how on some occasions people can be so fully engaged in achieving a goal that they lose track of time, concentrating so narrowly and consistently that they later report having had an optimal experience. He has titled this phenomenon "flow." Csikszentmihalyi (1990) described flow using a reprentation-based information processing perspective stating that "Everything we experience—joy or pain, interest or boredom—is represented in the mind as information." This description unfortunately leads inevitably to the questions that arise from mind–body or mind–matter dualism, such as "who or what is perceiving this mind-stored information and how does that perception and action occur?" This can quickly lead to infinite recursive descent and a less than satisfying account of how thinking and learning occur.

A more parsimonious description of flow can be provided using an ecological psychology perspective. From this perspective, flow emerges when the environment affords immediate and direct progress toward one's intended goals and affords opportunities for close coupling from which can arise immediate and continuous feedback. In short, flow is the result of an optimal match between the goals and intentions of a learner and the affordance of the environment on a specific occasion. This interactional account of flow does not place the controlling information inside the head of the learner, but leaves it out in the environment, with the learning bringing to it a goal, the path to which is clearly reachable under the environmental circumstances. Flow could be thought of as the ultimate level of motivation as ecologically defined, an ideal match of goals and affordances with clear and continuous opportunities for feedback. Flow is a good example of how variables and processes that have been discovered through research from the information processing perspective, can also and perhaps more parsimoniously be explained using ecological psychology.

7.4.5 Misconceptions

Young and Znamenskaia (2001) conducted a survey of preservice teachers in their junior year in college. The survey asked several online free-response questions about the student's understanding of what educational technology was, how it might be wisely integrated into the classroom, and the attributes one might look for in exceptionally good applications of technology to instruction. These novice preservice teachers gave responses that differed in quality and sometimes in quantity from those of experienced technology-using educators who had risen to the role of university scholars in the area of educational technology. The responses exhibited what might commonly be called "misconceptions" about educational technology. Ten such "misconceptions" were identified. They include the idea that educational technology only refers to computers and not other technologies such as video; the idea that the major cost of instructional computing is hardware, ignoring the costs of training, recurring costs of connections, and software; and the idea that the primary reason for using a program such as a word processor is for students to obtain pretty printout, ignoring the value of easy revisions, outlining, tracking changes or the multimedia capabilities of word processing programs.

But rather than label these observations "misconceptions," our preference was be to label them "naïve perceptions." This highlights our bias toward perception rather than memory, and clarifies that the differences may not lie solely in cognitive structures, but rather in the goals for perceiving and acting that future teachers have—goals that emerge from their environment (university classes) as compared to the environment of experts (applications development and K–12 classes) or even those of practicing teachers (have students learn content and/or perform well on standardized tests). We preferred naïve perceptions to "misperceptions" in that they were not "wrong," but rather were not seeing all the possibilities for action of educational technology. They needed to differentiate and pick up more of the affordances that were available to be detected.

Viewed this way, the "treatment" to remediate these naïve perceptions would not be simply informing students of the expert's responses, but instead, it would involve inducing future teachers to adopt new goals—goals that would enable them to see (detect) the many different ways in which educational technology (broadly defined) can be applied to lesson plans (i.e., enable teachers to detect the affordances of using educational technology). So rather than an instructional process, we advocated a "tuning" process of both intention and attention. Tuning *intention* in this case meant creating learning experiences in which future teachers could adopt realistic goals for integrating technology into instruction (Young & Barab, 1999). In this way they might experience the need to be driven by some sense of how students think and learn, rather than mindlessly applying the latest technology to every situation. Tuning *attention* in this case would be accomplished by providing rich contexts (hardware, software, and scaffolding for learning) that would afford students the broadest possible range of actions (e.g., integrating assistive technology, the Internet, simulations, productivity tools, video, construction kits, probeware, teleconferencing, manipulatives) through which to reach their newly adopted goals.

Further, Young and Barab (1999) proposed that such tuning of intention and attention, enhancing the naïve perceptions of preservice teachers so they can detect all the rich affordances for action that educational technology experts detect, would optimally take place within a community of practice (Lave & Wenger, 1991; Young, 1993). Such communities of practice (with goals to perform a profession competently) and communities of learners (with goals to engage in activities that optimize opportunities for tuning of intention and attention) are types of "collectives" with shared intentionality as discussed above. Future teachers with naïve perceptions of educational technology would be part of a community whose goals included the wise integration of technology into instruction, and whose members include a mix of relative novices and relative experts, working together toward a shared authentic purpose. This participation (action) in context might lead to the preservice teachers adopting the goals of the more-experienced peers.

7.4.6 Schemas

A schema is defined traditionally as an organized abstracted understanding, stored in memory, that is used to predict and make sense of events as they unfold. But from an ecological psychology perspective, schemata must be seen as the results of agent–environment interactions as they unfold on a specific occasion. The ecological psychology description of a schema rests as much with regularities across events as it does with stored abstracted understandings in the head.

Evidence for schemas comes from the things people recall about sentences they read (Bransford & Franks, 1971) or add to their recollections of videos they watch (Loftus & Palmer, 1974) since they often recognize a holistic view rather than literal sentences and tend to incorporate and integrate information from subsequent events with recollections of initial events (e.g., postincident news reports biasing recall of video tapes of automobile accidents). Roger Schank provided a classic example of schemas in describing restaurant "scripts" (Schank & Abelson, 1977). He described the abstracted expectations that arise from the normal flow of events that typically happen in restaurants; namely, you arrive, are seated, you view the menu, order, wait, eat, pay, and leave. This "script" is then violated walking in to most fast-food restaurants in which you arrive, view the menu, order, pay, wait, find a seat, eat, and leave. Such violations of the script highlight the fundamental way in which scripts, as a particular type of schema, guide our understanding of the world.

However, the regularities of events that are believed to be abstracted and stored in scripts are a natural part of the environment as well. As we experience one restaurant after another, there is the possibility to directly pick up the invariance among the occasions. So after five traditional restaurant experiences, it may be possible to detect, and proactively perceive what is coming next, when entering the sixth traditional restaurant. The invariant pattern would also be violated on the occasion of a fast-food restaurant visit. That is, when defining events and perception that is meaningfully bounded rather than bounded in space and time, it is possible to say that the schema, at least the invariant information that defines the restaurant script pattern, is there to be directly perceived. It therefore does not require abstraction, representation or storage inside the head of the perceiver to be noticed and acted upon.

7.4.7 Assessment

Assessment is a theme running through nearly all instructional design models. Formative and summative assessments are integrated into the instructional design process, as well as individual and group assessment of learning outcomes that provide feedback to students. An ecological psychology approach to this focuses attention on the purpose or functional value of such assessments and leads to a recommendation that assessment should be seamless, continuous, and have functional value for the learners as well as the assessors (Kulikowich & Young, 2001). Young, Kulikowich, and Barab (1997) described such seamless assessments placing the target for assessment on the learner–environment interaction rather than using the individual or class as the unit of analysis. Kulikowich and Young have taken this further describing a methodology for an ecologically based assessment that provides direct assistance to learners throughout their engagement with the learning context, much like the flight instruments of a fighter jet enhance the pilot's abilities to detect distant threats and plan complex flight patterns.

From this perspective, a primary assessment goal for instructional designers is to assess a student's true goals and intentions, those organizing and guiding the student's behavior. Then, if they are reasonably educative goals, the instructional designer can use the problem space defined by such goals as criteria for determining whether the student is on course for success or whether some scaffolding must be implemented. However, if the student's current goals are not deemed to be educative, then the task is to induce in the student, new goals that will constrain and organize behavior in the learning context.

Young (1995) described how learners working on complex problems with the help of a computer could be assessed using time-stamped logs of their navigation patterns from screen to screen, indicating their goals and intentions as a trajectory of events and activities. Kulikowich and Young (2001) suggested as part of their methodology that such ecologically valid assessments must have demonstrable value in improving the performance of the learners, and further should be under the control of the learners so they could be tuned and optimized for individual intentions. In this sense an ecological psychology perspective on assessment suggests that primary attention be paid toward accurately assessing learner's true goals, and then using the state spaces that are known to be associated with those goals, in the context of well-documented properties (affordances) of learning environments, to anticipate, scaffold, guide, and structure the interactions of learners as they move toward achieving the goals. The "trick" for the instructional designer, then, is to induce students to adopt goals that closely match what the learning environments that they have designed afford.

7.5 THE FINAL WORD

So what is different in instructional design from the ecological psychology perspective? First, primary attention to goals. The first task for instructional designers is to induce learners to have goals related to the isntructional materials and learning environments they design. Videos, authentic real-world and online experiences, and stories have proven effective in inducing students to adopt new goals that they did not come to class with. Then, the events of instruction should be organized to enable the close coupling of the novice with someone (man or computer) more experienced, creating a shared intentionality and coordinated activity (collective). In this way the learner's attention can be tuned by jointly perceiving and acting or at least observing vicariously the environmental information that specifies previously unperceived affordances. Finally, assessments must be designed to have functional value for the learners, extending their perception and ability to act in ways that tune their intentions and attentions to critical affordances of the world. This, then, is how people learn, leverage that can be applied by the instructional designer.

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