Establishing Practice Fields

The practice field is a metaphor introduced by Senge (1994) in relation to the practice field of sports where students prepare for the big game. It refers to learning contexts that are separate from the real field and in which learners can practice the kinds of activities that they will, potentially, encounter in the real world. These activities are situated within a context that has many of the environmental circumstances and surroundings that would be present had they been working on the problem in the context of the community that addresses this problem (Barab & Duffy, in press).

The design of rich practice fields has received much attention over the last decade (Barab & Landa, 1997; Barab, Hay, et al., in press; CTGV, 1990, 1993; Edwards, 1995; Hannafin, Hall, Land, & Hill, 1994; Hmelo & Evensen, in press; Komsars, Grabinger, & Dunlap, 1996; Koschman, 1996; Roth, 1996, 1998; Roth & Bowen, 1995; Reigeluth, 1999; Ruopp, Gal, Drayton, & Pfister, 1993; Young & Barab, 1999), and there have been many lists of principles for design of these learning contexts.

Problem-based learning (PBL) is an example of one approach to establishing practice fields. PBL, which has its roots in the medical profession, involves presenting students with real, but historical, patient cases to diagnose (Koschman et al., 1996). PBL has extended beyond the medical profession to include business schools (Milter & Stinson, 1995), elementary and secondary schools (Hmelo & Evensen, in press), higher education, and a host of other areas. Central to all of these instances is the goal of presenting students with "real" societal, business, or educational problems. The PBL approach differs from studying cases (Williams, 1992) in that the students in PBL environments are responsible for developing their position on the issue (their solution to the problem), rather than studying someone else's solution. Further, they are expected to identify what it is they need to know and learn to develop a solution, with problem-related "learning issues" being generated by the students (Koschmann, Glenn, & Conlee, in press). Thus they are engaged as if they were in the real world working on this problem, and there is an emphasis on increased ownership.

Anchored instruction, as advanced in the work of the CTGV (1990, 1993), represents another approach to creating practice fields. As with PBL, the goal is to capture a real problem and the context for that problem is drawn from the real world. In contrast to PBL, however, there is no pretense that this is a real problem. Rather, the learners are invited to engage in a fictitious situation that is occurring in a simulated real-world environment. Rich and realistic video contexts are provided not only to provide the information relevant to working on the problem but also to create the fictitious context. If the students buy into the proposed problems, then they will be engaged in some of the same sorts of problem solving in which the people in the simulation video would engage.

In properly designed practice fields, practices and meaningful relations emerge due to their functional value for task participation (Barab, Hay, & Duffy, 1998). These learning contexts provide sharp and useful contrasts to typical didactic learning in which the instructor imparts abstracted and frequently meaningless descriptions. However, in spite of their contextualized advantages, practice fields such as PBL environments or the work of the CTGV may be less effective in conditionally isolating the system than the real thing. Any time information is transferred out of its natural context, made more remote and disembodied from the learner, its meaning is made more elusive. Where context would have provided the constraints necessary for a conditionally isolated system in which learner and goal are bound together into a functional synergy, isolated classroom experience places a large demand on the teacher continually to contrive those constraints that will force the learner toward the goal. In the end, this creates more work for everyone, especially the teacher, and places the learner at unnecessary risk of missing the point.

In summary, although the goal in designing practice fields is to make the situation as rich as possible so that it simulates the conditions found in real-world situations, within the context of the classroom, designers are forced to make some decisions that exclude opportunity for full structural constraints and dynamics, for example, lack of true experts, lack of access to situationally responsive stimuli (e.g., the pertinent resources must be preassembled), and lack of functional outcomes that confer meaning on practice. As a result, many of the boundary conditions are not in place and, therefore, the system may not become conditionally isolated without the teacher's support. This challenges the facilitator to maintain some influence over the boundary conditions without interfering with intentional dynamics. We contend that the key element in doing this is to focus on the learner's adoption of the goal, that is, on seeding the intention.

SEEDING THE INTENTION: BUILDING DYNAMIC SYSTEMS

Effective instructional interactions can be said to have occurred when the learning episode embodies a degree of dynamic stability, the learner and facilitator share a goal, and learners participate in an instructional goal that organizes their thoughts and actions in its pursuit. Once they function within a single system, the original

*Clearly some classroom presentations are more effective than others (see Koschman, 1996, for some examples). If the learner has some prior, contextualized experience, classroom instruction is likely to be more meaningful. Or, for some newcomers (individuals who previously felt no membership to a community of practice), experiences with the PBL context may serve as an impetus to become a part of a particular community of practice. However, all too often these connections are the exception and not the rule.
goals held by the learner can interact dynamically with those held by the facilitator. Although the facilitator may have had a goal that directed the emergence of the shared space, ultimately, no one is in charge here. Neither participant solely sets the agenda. Each contributes to the construction of the boundary conditions that ultimately evolve. The choreography is emergent, as are the goals. The joint adoption of a shared or mutual intention requires a functional synergy between two or more cooperating team “players” (Smith & Smith, 1987). It is at that point that the actions of the participants are jointly mobilized around the path toward the currently held goal. It might be said that the participants are inside the same conditionally isolated system, the “construction zone” (Newman et al., 1989).

However, as stated previously, it is not the learner–facilitator coupling that is the ultimate purpose. Of prime importance is that the learner becomes coupled with the autocatakinetic of the learning context. It is the intention that couples learner and environment, serving to conditionally isolate the system and make certain participation paths more likely. Unlike decentered knowledge that has been abstracted and taught to the student by the teacher, a systems approach acknowledges that meaningful relations emerge through situated activity. It is the responsibility of the learning facilitator, drawing on his or her experience, to aid the learner in adopting those goals that most effectively attune him or her to the community available resources—or abandoning the goal if the learner is in the process of establishing an equally viable alternative goal that is personally meaningful or of broader relevance.

As a result, intentions are not merely shared. They may be of greater intensity for the learner. They might be broader for the facilitator than for the learner because the facilitator has more overlapping relations with the culture and with aiding learners in the enunciation process; therefore, it is the facilitator’s responsibility to recognize pitfalls and to provide corrective feedback. Facilitators are guided by their membership in a series of nested communities (i.e., school, town, society, alternative communities, as well as prior experiences) but are effective only to the extent that they use their authority justly and to the extent that they can respond to their learners. The facilitator is a vestige of the larger culture and, as such, provides field resources from which the learner can draw. Thus, the interaction is asymmetrical often with the facilitator having the responsibility of initiating the learner into those practices (including knowing about) and meaningful relations that are reflective of the types of relations occurring outside the school. However, one is not simply “schooling” the learner in terms of adopting cultural norms; rather the facilitator aids the learner in engaging in practices and exploiting available resources for the learner’s own self-forming, a process that not only expands the space–time dimensions available to the learner as system but also has the potential to expand the space–time dimensions of the facilitator and of those nested communities of which both are and will be a part. As long as a (any) joint intention maintains the learner and facilitator within the same goal-anchored system, the facilitator has the potential to influence the learner from within that conditionally isolated system, which is where, we argue, that true expertise emerges. We have come to believe that the coupling of learner and environment requires a solution path that is uniquely emergent from within the learner’s ecosystem and cannot be prescribed for the learner, independent of contextual particulars. When the learning situation fails to transcend the constraints associated with schools (e.g., teachers’ approval, grades, good jobs), there is a missed opportunity for a direct relation between knower and known.

Instruction should then begin with a goal that can be mutually held, one that reflects a merging of the curriculum and the learner’s preexisting propensities. The facilitator must create the mechanism for this to happen—that is, supply constraints of a kind and intensity adjusted to the learner’s current state and assist the learner in reaching an ever-evolving instructional goal. Once a merger across individual systems is achieved, the novice has access to the experience and awareness of the expert. However, the situation is delicate. Instruction must be well modulated, suited to the current tolerance of the learner. Constraints that are too strong threaten the potential for mutuality and may send the learner into a highly energized state and ultimately decreased organization (Cherkes-Julkowski & Mitilna, 1999). Constraints that are too weak fail to provide the impetus for higher levels of self-organization (Guess & Sailor, 1993). The facilitator, then, also serves as a regulatory agent within the conditionally isolated system.

CONCLUSIONS

Modern science has been built on a Cartesian or Newtonian (mechanical) paradigm. This paradigm, built out of the Cartesian legacy in which there was the separation of individual and environment, has contributed to an artificial view of mind in which learning is conceived as either the acquisition of objective, external structures from the world or the building of mental, internal representations in the mind. Rather than placing meaning, cognition, or knowledge in the environment as separate from the individual (as is frequently associated with constructivist views) or in the minds of learners as separate from the environment (as is frequently associated with constructivist views), we have advanced a relational ontology. In contrast to autonomous circular relations of closed-circle theories that refer only to themselves (i.e., theories that treat the individual or the environment in isolation), the circularity defining autocatakinetic systems refers to the autocatakinetic–environment relation. Building on the previous work of Swenson (1989a, 1997a, in press), we have argued that these systems come into being through, or in relation to, a particular ground that is neither the system nor that which it is not, and that there is no existence of self-reference for an autocatakinetic system independent of this relation. It is in this way that we have discussed knowing about, meaningful relations, and cognitive activity as fundamentally situated, that is, as part of a particular ground (context).
Drawing on theories of self-organization, we have argued that order is not something that the instructor brings to the learner; rather, it continuously emerges through an autocatakinetic process within the learner–environment system. We have argued that such system dynamics underlie (among other relations) the emergence of communities of practice, as well as the identity and functioning of individuals living within the community. Our explanation of autocatakinetic systems implies that any component, whether we are referring to a practice, individual, or community, must be considered in relation to the “other” through which it emerges (see Figures 2 and 3). Significance, then, does not exist in any one component (i.e., the individual or any other parsing of the dynamic relation); rather, it is spread across the various components in relation to the task at hand. On a related note, learning is not simply the acquisition of a set of preprocessed facts. Rather, we have argued for the necessity of each individual’s participation in the creation and functioning of his or her idiosyncratic learning experience, as part of an autocatakinetic system.

We have argued that educators need to establish trajectories that move student experiences from the classroom only (or even the PBL space) to real-world contexts in which what students are learning/doing takes on meaning because they receive natural feedback at all points along the way, including identifying the problem and progressing toward its resolution. Practice fields are designed to afford the emergence of contextualized practices and meanings, but they do so in the limited context and in the dynamics of schools. Although it is possible to contrive “realistic” problems that share many important attributes of real-world problems (Young & McNeese, 1995), they may form a conditionally isolated system with the learner where school-assigned meanings become the goal—complex problems are solved to get a good grade, completed for the purpose of satisfying a teacher or parent, not for the functional purposes for which these practices initially emerged. Once the problem is removed from its actual context and the intention migrates from problem solution to exploitation of institutional rewards (rather than exploitation of functional affordances), the quality of the system changes. This change has the potential of also altering the nature of the practice and the meanings that emerge.

We have tried to demonstrate how adoption of the goal embodies its own path to goal attainment; that adoption of a goal or intentionality in general is the manifestation of an autocatakinetic system in which the self–other, knower–known relation is maintained in a conditionally isolated system and that adoptable goals arise in contexts in which detectable invariance can be discerned. As such, a particular learning context is not meaningful or authentic because it is deemed so (Barab, Squire, & Duerer, in press); rather, meaning arises within (as part of) context (as meaningful relations), and it is the responsibility of the educator to support (scaffold) the learner in developing relations with the learning situation in particular and society in general. This is consistent with Dewey, Peirce, and others who argued for the necessity of experience. However, as Dewey (1925/1981) also argued, not all experiences have the same educational potential. Learning can occur anywhere, but deeper levels of enculturation involve full participation within systems that have relations with, are nested within, still larger systems.

We have outlined some of the key assumptions of an ecological paradigm, highlighting individual–environment relations and the importance of grounding learning in terms of its ecological function. Such discussions provide a foundation from which to conceive the method and goals for learning and instruction. The old Cartesian–Boltzmannian artificer view in which the particles (learners) were recalitrant and requiring external ordering (didactic instruction) is demeaning and ineffective. Schools are not simply responsible for the imparting of knowledge. We have suggested that educators have the responsibility of seeding learners into those conditions in which they can become active participants and thus adopt meanings and practices that best extend their own functioning and, in turn, their autocatakinetic development. Each development of this kind provides the basis for subsequent, higher order evolutions (Swenson, 1997c, 1997d).

**IMPLICATIONS**

Our intention in writing this article was not to advance a prescriptive approach for instructional designers. Rather, it was our intention to offer a principled explanation for how learning takes place through the individual–environment relation. Previous accounts have been lax in weeding out not-so-hidden dualisms (e.g., the problem of arbitrary constraints in both didactic instruction and in narrowly defined situated learning contexts). An adequate explanation for the self–other relation that is fundamental to learning has to be grounded in natural law that can account for how such relations form and order themselves. The ensuing challenge, of course, is to infer, from a principled account of learning, what form instruction would need to take.

Throughout much of one’s life, and especially in schools, one spends inordinate amounts of time experiencing preprocessed information—being handed descriptions of practices and meanings that were part of other people’s autocatakinetic systems. Schools may be thought of as most culpable in terms of relegating learning and instruction to processed information (delivered through didactic lectures and textbooks) at the expense of engaging learners in experiences through which practices, meanings, and ultimately identities emerge.

When official channels only offer possibilities to participate in institutionally mandated forms of commodified activity, membership, participation, and genuine access to information are rare (Barab & Duffy, in press). As a result, children can
develop identities only in relation to their ability to engage in commodified activities directed toward the production of grades (Walkerdine, 1997). For some students—"good students"—this helps enucleate them into the identity of a "successful" student. Some truly effective students are able to break away from these restrictions and form their own relation with the material. But for many others this context results in the "widespread generation of negative identities [under-achievers, failures]," as well as the emergence of "institutionally disapproved interstitial communities of practice [burnouts, trouble makers]" (Lave, 1991, pp. 78–79). Despite the school's effort to use the constraints of curriculum and discipline to direct recalcitrant students to the "preferred" goal, it is frequently their relation to alternative communities of practice that are the most personally transformative.

We hope that educators and researchers will continue to explore ecological methods for carrying out research and instruction that are predicated on self-organizing, not mechanistic, assumptions. In our opinion, such efforts will eventually redefine old and introduce new practices and methodologies that have the potential to transform the view of education as we now understand it—from one of acquiring programmed responses to one emphasizing active participation as part of a dynamic system. However, this move does not simply entail shifting from one dualist perspective to another (objectivist to constructivist) but involves adopting a relational ontology that draws on and couples individual and environment to the context in which they are grounded. This way of thinking requires the abandoning of the more traditional Cartesian dichotomies and the adoption of a relational ontology. If we cling too tightly to previous assumptions, we run the risk of ending up trapped like the monkey, eventually limiting our own opportunities and those of our students to see, to interact with, to become a part of, and to potentially change the world in meaningful ways.

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REFERENCES


Addressing the Challenges of Inquiry-Based Learning Through Technology and Curriculum Design

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Inquiry experiences can provide valuable opportunities for students to improve their understanding of both science content and scientific practices. However, the implementation of inquiry learning in classrooms presents a number of significant challenges. We have been exploring these challenges through a program of research on the use of scientific visualization technologies to support inquiry-based learning in the geosciences. In this article, we describe 5 significant challenges to implementing inquiry-based learning and present strategies for addressing them through the design of technology and curriculum. We present a design history covering 4 generations of software and curriculum to show how these challenges arise in classrooms and how the design strategies respond to them.

Students at all grade levels and in every domain of science should have the opportunity to use scientific inquiry and develop the ability to think and act in ways associated with inquiry. (National Science Education Standards, National Research Council [NRC], 1996, p. 105)

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