Authentic Activity as a Model for Appropriate Learning Activity: Implications for Emerging Instructional Technologies

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Abstract: In this paper, we discuss the implications of authentic activity as a mode1 of learning, particularly in the design of computer-based simulations and project-based learning activities. We first address the characteristics of real-life problem-solving situations, educational simulations, and authentic learning activities. We then identify three key guidelines in the design and development of authentic learning activities: (a) support the learner in establishing a learning enterprise. (b) insure that the learner practices what is essential for the transfer situation, and (c) base design decisions on values consistent with constructivist principles of teaching and learning. In our view. authentic activity represents a holistic and generative process of learning and motivation. Authentic learning activities place emphases on self-directed learning and on development of metacognitive abilities necessary to support it.

Résumé: Dans cet article nous étudions les implications de l'activité authentique comme modèle d'apprentissage, notamment dans la conception de simulations informatisees et dans les activités d'apprentissage a l'intérieur d'un projet. Nous nous penchons d'abord sur ce qui caracterise les situations de solution de problemes reelles, les simulations educatives, et les activités authentiques d'apprentissage. Nousidentifionsensuite troislignesdirectricesclés pour la conception et le developpement d'activites authentiques d'apprentissage: a) le support de l'apprenant dans l'etablissement d'un projet d'apprentissage, b) l'assurance que l'apprenant met les éléments essentiels a la situation de transfert en pratique, et c) des décisions sur les valeurs de conception de base compatibles avec les principes constructivistes de l'enseignement et de l'apprentissage. Nous pensons que l'activite authentique represente un processus holistique et generatif de l'apprentissage et de la motlvation. Les activités authentiques d'apprentissage mettent l'accent sur l'apprentissage auto-dirige et sur le développement d'aptitudes métacognitives nécessaires a son support.

Today, interest in learning through authentic use is widespread as the theory base for situated learning matures and as innovations in computer-based multi-media systems outstrip the development of theory-based instructional strategies (Dick, 1991). Beginning with Dewey (1972) and the progressive educators of the 1920s and 1930s theorists have argued that learning

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should take place in meaningful contexts where students work cooperatively to solve everyday problems. More recently, this idea has provided the basis for a number of educational approaches including cognitive apprenticeship (Brown, Collins, & Duguid, 1989), project-based learning (Blumenfeld, Soloway, Marx, Krajcik, Guzdial, & Palincsar, 1991), theme-based learning (Wager, 1994), guided microworlds (Rieber, 1992), computer-supported intentional learning environments (Scardamalia, Bereiter, McLean, Swallow, & Woodruff, 1989), and reciprocal teaching (Brown & Campione, 1990).

At the same time, the availability of powerful low-cost computers has stimulated interest in the design and development of simulations. Simulations have long been used to deliver instruction in schools, military, industrial, and other educational settings on the basis that they increase the ability of participants to apply what they have learned in the classroom to the real-world or transfer situation.

It is an often-stated conviction that producing transfer is the main job of education. Yet, an increasing body of research shows that the way students learn something in school often results in students knowing something but failing to use it when relevant. Brown et al. (1989) have concluded that this condition, originally identified by Whitehead (1929) as the problem of inert knowledge and also referred to as a transfer problem, occurs because classroom learning environments generally lack the contextual features ofreal-life problem-solving situations. With this problem in mind, Brown et al. have proposed that "understanding is developed through continued and situated use" (p. 33). They have further suggested that cognitive apprenticeships should be designed that immerse students in the culture of traditional academic domains by engaging students in authentic activity.

In this paper, we discuss the implications of adopting authentic activity as a model for appropriate learning activity, particularly in the design of computer-based simulations and project-based learning activities. The term "model" as used in this context is meant in the sense of something worthy of imitation and not in the scientific sense of a theoretical model of learning or instruction. We suggest, however, that there is much more to transforming the conventional classroom into an authentic learning environment than simply incorporating features of real-life situations into school work. Use of computer-based simulations and reality-centered projects does not insure that students will assume a positive orientation to learning or derive the benefits of in-context learning. Much additional support is required to strengthen the learners' tendencies to engage in intentional learning processes and to help them progressively assume responsibility for learning.

The following discussion is divided into three sections, organized around the following three questions that also serve as headings for the sections:

a) What characteristics of real-life problem-solving situations are different from problem solving in school?
b) What characteristics of educational simulations are most important?

c) What characteristics of authentic learning activity are most important'?

Question 1. What characteristics of real-life problem-solving situations are different from problem solving in school?

A primary principle of the cognitive apprenticeship framework is that understanding develops through application and manipulation of knowledge within the context of the ordinary practices of the target culture-in other words, through authentic activity. This principle represents the primary rationale for using authentic activity as the model for appropriate learning activities. It extends various cognitive theories of transfer that emerged from information processing theories of human learning and memory in the 1970s (e.g., Bransford & McCarrell, 1974). These theories stimulated thinking about developing educational practices to enhance far transfer and, more particularly, transfer from school learning to real-world situations (Royer, 1979). As Brown et al. (1989) suggested, conventional classroom tasks frequently lack the contextual features that support transfer from the school setting to the outside world. For advocates of situated approaches to learning, the provision of authentic activity in schools is a way to increase cognitive engagement, support meaningful learning, and facilitate transfer.

Table 1 summarizes differences between real-life problems and problem-solving activities typical of actual practitioners versus problem solving typical of students in school that are particularly relevant to the design of authentic activities. The differences identified in the table are further elaborated below.

TABLE 1
Real-Life Versus In-School Problem Solving

Real-Life
1. Involves ill-formulated problems and ill-structured conditions.
2. Problems are embedded in a specific and meaningful context.
3. Problems have depth, complexity, and duration.
4. Involves cooperative relations and shared consequences.
5. Problems are perceived as real and worth solving.

In-School
1. Involves "textbook examples" and well-structured conditions.
2. Problems are largely abstract and decontextualized.
3. Problems lack depth, complexity, and duration.
4. Involves competitive relations and individual assessment.
5. Problems typically seem artificial with low relevance for students.

1) Real-life problems are frequently ill-formulated and conditions are ill-structured. Understanding develops through experience in multiple case contexts and from multiple perspectives within the same context. In school (and more generally in the design of instruction), performance requirements are simplified and the learning situation is well-structured (Spiro, Feltovich, Jacobson, & Coulson, 1991).

2) In real life, skill practice is embedded in performing some larger task at hand that justifies developing the skills in the first place (Brophy & Alleman, 1991). The larger task serves as an integrating structure or enterprise that helps organize new information and lends meaning and purpose for learning. Individuals assume responsibility for establishing and monitoring their goals and strategies when the reasons for performing procedures, even tedious ones, are understood within the context of a broad, global task environment (Honebein, Duffy, & Fishman, 1994). In school, teachers often assign students to low-level work involving recognition and reproduction of memorized information or practice of isolated skills, without providing links to a larger functional context (Doyle, 1986). All too often, the primary enterprise for students is to pass tests rather than apply new knowledge and skills in meaningful ways.

3) Real-life projects frequently have depth, complexity, and duration (Berliner, 1992). When people engage in active and generative problem-solving activities that involve personal values and beliefs, they experience a feeling of ownership over the activity and its goals and thus, the tendency to engage in intentional and self-regulated learning processes is enhanced. “School activities” generally lack depth, complexity, duration, and relevance to the real world. Teachers and students are constrained by requirements to cover “essential” content.

4) In real life, the intelligence to solve a problem or perform an activity is often distributed across a group of peers, a learner-mentor system, and/or an electronic performance support tool (EPSS), or other form of cognitive technology (Pea, 1993). The quality of interactions among participants is frequently of primary importance in undertaking a project or accomplishing a goal. In school, teachers serve as authoritative sources of all information rather than as guides or information managers. Relationships between students are predominantly competitive rather than cooperative, as individualistic modes of learning and assessment are generally the norm. When group activities do occur, students are usually judged exclusively on what they can do on their own.

5) In real-life, all problems do not have previously known solutions or just one possible explanation. When people work collaboratively on solving real-life problems, they share in substantive conversation, which has a different quality from conventional school talk (Newmann, 1991). An individual’s orientation toward learning is qualitatively different when learning is embedded in the context of achieving personally relevant and valued goals versus working for a grade or some distant, future goal. In school, problems are often

artificial and of no particular interest to the students. Students who see no relevance in the problems, also see no relevance in the knowledge and skills required to solve them.

Question 2. What characteristics of educational simulations are most important?

The theoretical assumptions underlying the designs of simulations are as varied as the purposes for which they are used and the contexts in which they appear. According to Cunningham (1984), a simulation duplicates some essential aspect of reality for purposes of experimentation, prediction, evaluation, or learning. An educational simulation is designed to increase one's ability to respond appropriately in a real-world or transfer setting. It allows the learner to practice decision-making, problem solving, and/or role playing in the context of a controlled representation (model) of a real situation (Smith, 1986).

From an instructional-design perspective, educational simulations support predetermined learning outcomes by providing users with opportunities to deal with the consequences of their actions and to respond to feedback Within Pea's (1985) framework of distributed intelligence, computer-assisted simulations have the potential to reorganize mental processes by "closing of the temporal gaps between thought and action [and] between hypothesis and experiment" (p. 85). Pea envisions a partnership between computer and student that extends and redefines thinking capabilities and transforms how problem solving occurs. Such effects are made possible by allowing the user to engage in "what-if thinking" where the consequences of different approaches to a problem may be displayed immediately.

In the literature on simulation, the definition offidelity varies depending on the context to which it is applied and the theoretical orientation of the author. For example, in proposing a model for assessing the fidelity of task simulators used in industry, Bruce (1987) identified three criteria: a) physical similarity; b) functional similarity; and c) task commonality. After assigning a value to each category involved, the values are combined to produce a fidelity index for a particular training device. In contrast, Smith (1986) believes that the essential reality factor in a simulation is not its form but the information-processing demands it imposes on the learner. He has called this its "cognitive realism" the degree to which the simulation engages participants in a decision-making or problem-solving process that parallels the mental activities required in the transfer situation.

Oddly enough, research does not support the idea that maximizing realism, or fidelity of a simulation maximizes learning outcomes (Alessi 1987). With this in mind, Reigeluth and Schwartz (1989) recommended that when designing for a novice learner, it is best to start with low fidelity and to add fidelity and complexity progressively. Similarly, Blumenfeld et al. (1991) have proposed that a great strength of simulation for instructional purposes is its potential to allow students active exploration in simplified environments. They believe that when extraneous details are minimized, interactions among variables are easier to notice than in a highly realistic simulation or in the transfer environment itself.

Reigeluth and Schwartz (1989) have described three major elements in the design of computer-based simulations that they believe determine their effectiveness: the scenario, the underlying model, and the instructional overlay. They have suggested that the scenario (the situation and the learner interface with the simulation) and the model (usually a mathematical formula for establishing causal relationships) should duplicate to some degree the essential characteristics of the transfer situation. In other words, the characteristics of the scenario and the model determine whether essential aspects of the transfer situation are represented, although how to identify such essential characteristics is not addressed. Reigeluth and Schwartz have concluded, on the basis of their own analysis of simulations, that the instructional overlay (the features that function to optimize learning and motivation) are generally the weakest aspect in educational simulations.

One element of the instructional overlay that Reigeluth and Schwartz (1989) feel should receive more attention from designers is artificial feedback. Alessi and Trollip (1985) have distinguished between natural feedback that the real-life situation provides, and artificial feedback that the designer builds into the simulation. One of the strengths of simulation for instructional purposes is its potential to shelter learners from costly forms of natural feedback (skidding into a snow bank) and to provide real-time artificial feedback (aural, verbal, or visual instructions to turn in the direction of the skid.)

The simplifying-conditions method proposed by Reigeluth (1993) appears to take advantage of strengths inherent in simulation without sacrificing authenticity of the learning activity. In this method, experts identify (a) a simple case that closely represents a real-world task and (b) the ways in which this “epitome” version of the task differs from more complex versions. Over time, complexity and variations are added systematically to the learning activity with the expectation that the method preserves the potential benefits of in-context learning. Reigeluth has claimed that this is a more holistic way to sequence instruction than the traditional parts-to-whole approach and is compatible with context-based design models.

The ideas that sequencing within a simulation should progress from simple-to-complex and that different levels of fidelity and complexity are appropriate for different levels of learners appear to be inconsistent with constructivist principles held by a number of theorists. For example, Honebein et al. (1994) believe that the learning situation should parallel the transfer environment with all its complexity and messiness. They have argued that the complexity of the learning environment in the early stages of learning should reflect the complexity of the authentic context to the extent practical. Otherwise, when instructional designers simplify the learning environment, they may unwittingly alter the metacognitive and affective demands of the authentic task complex.

Carroll (1990) has suggested that in order to facilitate transfer, promote metacognitive and affective learning, support an adaptive motivational pattern to learning, and encourage a high degree of ownership and personal relevance, educators should provide training on real tasks. Similarly, Spiro Vispoel, Schmitz, Samarapungavan, and Boeger (1987) believe that "case; and examples must be studied as they really occur, in their natural contexts, not as stripped down 'textbook examples' that conveniently illustrate some principle" (p. 181). From this perspective, the role ofinstruction changes from controlling student learning through imposing a simplifying structure on the environment to developing appropriate "scaffolding," including new strategies, tools, and resources that support the student in functioning within the authentic learning context,

Of note, Spiro et al. (1991) have identified two factors that determine when it is appropriate to maintain the complexity of the transfer environment within the learning situation, and when it is more effective to simplify the learning situation. They distinguish between a) well-structured domains versus ill-structured domains; and b) introductory learning versus advanced learning. Whereas instruction that focuses on general principles with application across cases is effective in well-structured domains, such an approach may impede attainment of more ambitious goals in ill-structured domains. To attain high-level thinking skills in ill-structured domains, the learning environment should provide experience in multiple case contexts and from multiple perspectives within the same context.

Theorists hold a variety of viewpoints on when to maintain the complexity of the transfer situation within the learning situation and when to simplify the learning situation. Vygotsky's (1978) concept of the zone of proximal development (ZPD) and Pea's (1985) ideas concerning distributed intelligence appear particularly relevant to this concern. The ZPD represents the limits of an individual's development defined as the distance between independent problem solving and what a person can accomplish under adult guidance or in collaboration with more capable peers (Vygotsky, 1978). Pea has suggested that technology, in Vygotskian terms, can expand zones of proximal development to enable novices to engage in problem-solving activities that would otherwise remain beyond their reach. From this perspective, intelligence may be distributed across a system not only through collaborative efforts but also as a result of the partnership between learner and computer (Pea, 1993). This suggests the following principle: The complexity of the learning situation should not exceed the capacity of the environment to adequately expand the ZPD through both social and technological scaffolding.

Question 3. What characteristics of authentic learning activity are most important?

Examined from a variety of viewpoints, the assumption underlying most traditional educational practices that knowledge is context-independent, appears increasingly difficult to justify. A renewed educational awareness is growing that recognizes the priority of supporting higher mental processes through situated learning and the collaborative construction of meaning. Although educators have long recognized the need to foster higher order thinking skills and positive disposition toward learning, they have disagreed about how to achieve these ends (Resnick, 1989).

The idea that students need to acquire facts and theories as conceptual tools for solving problems in meaningful contexts, rather than for maximizing success on "school" tests, has led to an interest in apprenticeship learning and learning through authentic use (Brown et al., 1989; Pea & Gomez, 1992). Results from cognitive skill research that examine differences between experts and novices support this view. Experts and novices differ in many ways other than the amount of subject matter mastered, including "the organization of knowledge, the ability to process problems in depth, and the appropriateness of the mental model possessed by the learner" (Royer, Cisero, & Carlo, 1993, p. 235).

The notion of authentic activity is based on the idea that the learning situation should help learners develop ways of thinking and acting that characterize the target culture or professional community. This does not mean, however, that design for authentic learning activity is merely a matter of maximizing the similarity of the learning situation to the transfer environment. As is explained through Tripp's (1994) example below, design for authentic learning is also concerned with the values that the learning environment supports and models, and whether the learner practices what is essential for the transfer situation.

Tripp (1994) believes that one way to learn something about instructional design is to analyze proven educational approaches by reverse engineering them and trying to extract some principles. For example, he believes that the instructional model applied in the education of Pacific navigators for over a thousand years represents such a proven approach. Although Pacific Islanders educated their navigators in part through informal situated learning at sea, much of the students' education occurred in a formal instructional context. For example, instruction in wave pattern recognition and star relationships was done on land with substitute media-stick charts, stone canoes, and the interior of a building that served as a kind of low-fidelity planetarium — even though real waves and stars were readily available.

One principle that Tripp (1994) derived from his analysis is as follows: "Reality is not necessarily superior to artificiality. When reality is subtle or complex, substitute media that increase saliency by simplification are more efficient" 3). The neophyte navigator knows in a meaningful way that what he is learning is necessary for his survival. The idea that he is engaged in a learning enterprise, in Gagne and Merrill's (1991) terms, is well established in his mind before he enters the formal phase of training. Thus, in this case, authenticity is primarily a quality of the larger task environment as understood by the learner.

Tripp's (1994) analysis illustrates a fundamental principle of instructional design that emerges from an open-systems view of the learner: The orientation of the individual to learning is part of the learning context Learning orientation encompasses an individual's beliefs about the nature of knowledge and how it is acquired as well as personal goals, expectations, and attitudes. Considered as a whole, these factors influence students' cognitive engagement and the learning activities they employ.

From an open systems conception, human learning is essentially a matter of self-regulation. It is a process of making sense, where external perturbations, anomalies, and errors trigger internal transformations toward reorganization and new understanding (Doll, 1989). With an open systems model of the learner, the role of instruction is to support the process of meaning-making by influencing the thinking processes students use to learn and sustain motivation, rather than controlling external conditions to achieve pre-set ends.

Buchanan (1992) has suggested that since conditions are ill-structured and problems are ill-formulated in many areas of human endeavor, all but the most clearly linear design problems assume a fundamental indeterminacy. Von Bertalanffy's (1967) distinction between open and closed systems is relevant to this view. Closed systems such as cybernetic or feedback systems are open to information but do not exchange matter with the environment. Open systems, on the other hand, such as organisms and other living systems are maintained in a continuous exchange ofcomponents. Instructional design within an open-systems framework recognizes the constructive nature of reality and further requires a shift in preferred metaphor for education from transmission of information to building representations of meaning.' In a sense, an open system is open to possibilities.

Based on our own design experience and on the literature related to constructivist philosophy, higher order thinking, achievement motivation and computer-supported collaborative learning environments we have tentatively identified a set of interrelated values that may guide educators in the design of authentic learning environments. In the face of what Doll (1989) describes as an emerging post-modern agenda for curriculum the traditional ID values of replicability, reliability, communication, and control (Heinich 1984) appear increasingly restrictive. An alternative (and not necessarily mutually exclusive) set of values has emerged including mutual inquiry collaboration, multiple perspectives, pluralism, personal autonomy activity' reflectivity, generativity, authenticity, complexity, personal relevance, self-regulation, ownership, and transformation (Lebow, 1993). These values are supported by a growing body of educational research and theory that advocates holistic and generative approaches to education and the use of technology to assist students in developing higher order thinking skills and important long term dispositions toward learning.

When the design of instruction is guided by such values means and ends become integrated and the desired results and preferred instructional techniques and strategies appear as reflections of the same whole. To put this in other terms, when the transfer task is the model for the learning activity, means support values inherent in ends. For example, to develop interpersonal skills for sustaining cooperative group work is both a goal of instruction and a means to achieve the goal. Students practice group process skills in the context of achieving personally relevant goals. Another goal, to develop the ability to reflect on one's own learning processes, is also a means to self-correction and self-regulation of the learning process. Within an authentic learning activity, instruction is a model for the values that instruction is designed to support, and, in line with the concept of continuous progress, a good test is also a good learning activity. As a result, students experience the relevance of new information, not by being told about its relevance, but by experiencing changes in perceptions, understandings, beliefs, feelings, and capabilities as a function of new information (Bransford, Franks, Vye, & Sherwood, 1989).

Gustafson (1993) believes that the fundamentals of instructional design must change in response to mounting evidence supporting the claims of cognitivists and constructivists. He has suggested that "what we now await is a much greater amount of specific guidance on how to apply cognitivism and constructivism, such as we have for behaviorism" (p. 30). Our current research efforts are pointed in this direction as we develop a set of guidelines that will serve to make the application of constructivist values to the design of instruction more concrete, in two ways. The guidelines will (a) provide information on how to design for higher order thinking skills and positive disposition toward learning and (b) suggest solutions to a variety of classroom management issues that may arise when authentic activities serve as the model for learning activities.

The guidelines initially emerged from a review of literature about how cognitivist and constructivist principles may contribute to the design of complex learning environments, and to an understanding of how to use emerging technologies in education. We are now in the process of refining the guidelines based on results of our own research efforts in examining a prototype computer-supported learning environment for graduate level education.

At this point, we have organized the guidelines into four main categories including collaboration, ownership, meaning, and practice as a framework for communicating our ideas and as a basis for future research. Taking the first letter of each category provides the convenient mnemonic of COMP. Under each category, we have listed a number of tentative goal statements that reflect instructional design principles consistent with constructivist and cognitivist thinking and in line with the values mentioned previously. Although it is beyond the scope of this paper to report on our progress in this area, an example of a goal statement from each of the COMP categories is offered below:

1) ***Collaboration:*** Provide students with opportunities to engage in activities traditionally reserved for teachers by a) shifting from all students learning the same things to different students learning different things; b) creating group problem-solving situations that give students responsibility for contributing to each other's learning; and c) helping students see the value of what they are learning and choose to share that value.

2) Ownership: Support development of reflective self-awareness and other self-regulated learning skills as the basis for assuming personal responsibility for learning by a) providing new structure, process-relevant feedback and sufficient time to support reflection on the learning process and to help learners experience the value of self-monitoring; b) modeling and offering coached practice at self-questioning and other metacognitive skills for developing both executive control of learning activities and critical thinking skills for evaluating intellectual products including one's own; and c) promoting meta-affective skills for increasing ability to concentrate and persevere.

3) Meaning: Support development of a learning versus grade orientation to the academic enterprise and help learners build commitment to their goals by a) embedding the reasons for learning something into the learning situation and helping students learn something in a way that includes experiencing its significance or function; and b) providing opportunities for students to experience how increasing cognitive engagement is tied to achievement of personally relevant goals.

4) Practice: Support development of cognitive flexibility by providing a) problem-solving experience in multiple case contexts and from multiple perspectives within the same context; and b) repeated practice in environments similar to those in which learners will use their problem-solving skills (Spiro et al., 1991).

In summary, authentic activity is consistent with a holistic and generative view of learning and motivation that places emphases on self-directed learning and on development of metacognitive abilities necessary to support it. From this perspective, the traditional split between cognition and affect is seen as an often unproductive application of reductionist thinking. When authentic activity is the model for appropriate learning activity, the perceptions of the learner and the affordances of the environment represent an integral and inseparable context of learner/environment. The implications for instruction are primarily threefold: (a) design must support the learner in establishing a learning enterprise within the larger global task environment (b) the learning situation must afford the kinds of activities essential success in the transfer environment, and(c) the instructional designer should base design decisions on values consistent with constructivist principles of teaching and learning.

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