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Are constructivism and computer-based learning environments incompatible?

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Are constructivism and computer-based learning environments incompatible?

Posted on **April 1, 2002** by **Editor**

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Calls for the widespread use of computer-based educational technology often justify themselves by the potential to support some version of constructivism, seen to be a major improvement in education over more behaviorist or information transfer notions of teaching. In a seminal article, Allan Collins, an early proponent of constructivism and a leader in forming the field of cognitive science, contrasts two views of pedagogy that “have been at war for centuries”: the didactic and the constructivist (Collins, 1991, p. 29). Here Collins associates the didactic view with the behaviorist and information transfer models of teaching where the facts and concepts of a domain are directly taught to students. Constructivism shifts the attention from teaching to learning where students are to “construct their own understandings and capabilities in carrying out challenging tasks” (Collins, 1991, p. 29). Collins further links constructivism and technology implying that the new technology requires moving to this new philosophy of pedagogy.

The purpose of this article is to support my claim that the facile association of computer-based educational technologies as inherently constructivist cannot be sustained. Further, much educational software and many web sites are retrograde in the sense that they largely incorporate behaviorist or information transfer strategies that are antithetical to a constructivist philosophy. I will confine my claim to what I call “learning environments” which I define as software or web sites organized to be the primary source of information and interaction for the learner. Web-based courses which are primarily intended for individual learner use would be an example of such an environment. Often, in public schools, web sites are organized into a “webquest” which involves one or more students seeking information from a set of web sites, largely without teacher intervention. Such webquests would be another example of a computer-based learning environment.

Let’s review the primary components of most constructivist learning philosophies to see why it is difficult to build a constructivist computer-based learning environment.

The writings of Piaget are considered to be the foundation for constructivism (Phillips, 1995; Smith & Ragan, 1999). Piaget’s genetic theory based on principles of evolutionary biology was the basis for his theory of cognitive growth. For Piaget, it is in the nature of the organism (and the student) to be active (Fancher, 1990). Pedagogically, this view “focuses on the interactive, dialogic

relationship between the learner and the learning environment, including the material presented by the teacher” (Doll, 1993, p. 81). Piagetian ideas are also credited with leading to the characterization of the child as a problem-solver, emphasizing learning as active invention (Bruner, 1986).

Piaget also assumes that there will be a certain inertia in students that makes it likely that they will “continue in past patterns as long as possible” (Doll, 1993, p. 83). Thus, the environmental (i.e., learning environment) conditions must be such to invoke a “deeply felt” (Doll, 1993, p. 83) disequilibrium. For Piaget, the teacher’s job was both to foster a deep sense of disequilibrium while at the same time constraining it to manageable levels so that the student does not get overwhelmed.

Vygotsky, the 20th Century Russian educational theorist, provided a foundation for socio-cultural theories of learning that have become part of the constructivist tradition. Vygotsky considered that cognitive development was “inherently integrated with social and emotional development” (Forman & McPhail, 1993, p. 215&216). Vygotsky’s central theoretical concept was the notion that socially shared activities are transformed into individual mental processes and cognitive development (John-Steiner & Mahn, 1996; Vygotsky, 1978). This expands on Piaget’s view of the importance of learning in interaction with the environment to stress the central role of the cultural context in which that learning takes place. Interpersonal social interaction of a learner with his or her peers and with the teacher is considered a key pedagogical strategy to facilitate learning.

Other constructivist strains have grown out of Vygotsky’s ideas linked with anthropological and cognitive theories. Anthropological research in the early 1990s on problem solving within cultural groups outside of the institutions of school (e.g., Lave & Wenger, 1991; Rogoff, 1990) led to the notion of situated learning where cultural and contextual clues supported the learner in the context of realistic activities. For instance, children in some cultures were shown to have facile computational skills for money changing in the context of selling in spite of their lack of knowledge of school-based arithmetic. Such contexts are considered more “authentic” because the nature of the task (e.g., exchanging money) grows out of some more basic need than simply a need to know arithmetic.

From this brief account, we can summarize the main pedagogical components commonly associated with constructivism. First, a cognitively engaged learner who actively seeks to explore his or her environment for new information.

Second, a constructivist pedagogy often includes a hands-on, dialogic interaction with the learning environment. So, for example, manipulating unifix cubes in early mathematics would be considered critical to learning early math concepts. Or, for another example, actually designing software is preferred to simply being told how to design software. In this case, the “dialogic” nature of the task is the learner struggling with the constraints of the design environment.

Third, a constructivist pedagogy often requires a learning context that creates a problem-solving situation that is authentic in nature. Another way of saying this is that the learner is placed into a context in which the environment itself provides a context in which the information to be learned or applied makes sense as a satisfaction of a reasonable learning goal. Such situations can be, for example, a design context where the solutions are constrained by the materials, tools and processes available.

Fourth, constructivist environments typically include a social component often interpreted as actual interaction with other learners and with mentors in the actual context of learning. While some have argued that a learner's interaction with cultural artifacts (e.g., a software program) can be counted as "social", it is safe to say that most constructivists consider human-to-human interaction primary.

Over the last four decades educational learning theory has evolved from behaviorism through cognitive information processing to the current emphasis on constructivism. An example of a pedagogical strategy arising from a behaviorist tradition is including practice and repetition as a fundamental part of the learning process. Cognitive information processing theories hold that there are fundamental principles guiding how people learn and those principles can be derived from how they process information. For instance, a familiar information processing principle holds that people cannot handle more than seven plus or minus two items comfortably at any one time. Such a principle leads directly to an instructional design strategy that suggests presenting from five to nine items at any one time to the learner. Both the behaviorist and the information processing views typically consider that there are domains of knowledge and the teacher's (or instructional designer's) job is to transmit the facts and concepts of the domain to the learner through lectures, recitations, or planned instructional sequences. Further, instruction should provide for review and practice until the learner has mastered these facts and concepts.

A look at the current state of computer-based learning technologies indicates why a constructivist environment remains out of reach. As an example, let's look at a hypothetical web-based course. In particular, the web-based interactive quiz, an advanced technology not available a few years ago. While certainly increasing the interaction available to the student over a passive viewing of content, the interactive quiz nevertheless requires a short answer or multiple choice format. This is a technique long associated with an information transfer view of teaching and learning: present the material and then test how well it has been learned. Constructivism, on the other hand, calls for students to show their understanding in deeper ways, to explain or demonstrate their knowledge by synthesizing previously learned information into new inferences or design solutions. Such quizzes do not allow this. The current quiz technology, while an impressive improvement in software technology, is not an improvement in educational practice.

My own view is that technology can be used to support constructivism but is neither inherent in it nor necessary for it. My concern is to counter the much stronger claim that these new technologies will inherently transform learning and that transformation will be constructivist. Often this is extended to the claim that the better the underlying software technology the better the

transformation of learning. I recently attended a talk by one of the participants in a major web-based course development project. The project included interactive quizzes, video-based vignettes, and hyperlinked concepts intended to engage the learner in ways superior to earlier technologies. The speaker touted the benefits of a constructivist viewpoint as a guiding philosophy of the design. Yet when examples of the courseware were demonstrated it became clear that constructivist principles were little in evidence. First, the interactive quizzes used behaviorist principles of drill and practice. Second, the video-based vignettes were didactic in nature presenting their message in a somewhat patronizing tone characteristic of early instructional television. And finally, the hyperlinked concepts were organized according to the concepts of the field as is customary in traditional instructional design, a reasonable and effective strategy, but not primarily constructivist in nature.

I identified four components of a constructivist learning context: an engaged learner, hands-on interaction with the materials of the task, an authentic problem-solving context, and human interactions during the process. If we look again at the hypothetical web-based course we will not find all of those components at work. It is still out of reach to provide hands-on interaction with the materials of the task (i.e., an ability of the learner to really control all aspects of his or her learning rather than simply selecting among pre-determined choice points or predetermined content). It is still difficult to provide an authentic problem-solving situation although much good research is being done in this area. And it is certainly now largely impossible to provide human interaction without, you guessed it, the explicit inclusion of human interaction in the process (which points to the possible role of software to support cooperative work such as some of the elements of BlackBoard or WebCT—but that is the subject of another article).

All this said, it is important to point out that there are lots of ways that computer-based educational technology can be useful in education. But, if it is a constructivist learning environment we seek it is still out of reach to provide one using technology alone. My point is only that we must be careful to distinguish what is constructivist from what is not. By claiming that technology is inherently constructivist and encouraging its use uncritically in classrooms or as a replacement for teachers we may actually be fostering educational retrograde motion. A typical approach common on many teacher support websites is simply to list a set of URL's appropriate for certain lessons and a set of guiding questions that can be used to test kid's knowledge of what they have found at those sites. I have seen teachers who, without the technology, implement rich constructivist environments, but when using these web-based lesson plans fall back on techniques little more than glorified look up tasks.

That is not to say that these technologies are worthless, indeed they may provide much needed assistance and open new learning possibilities. The point is that one must be acutely aware that the use of these tools constrains the possible pedagogy that can be used. It takes a very creative teacher to implement a constructivist pedagogy with technology rooted in behaviorist theories. Not many teachers have the time to be that creative (or the support). This means that increasing use of computer-based technologies will likely, at least in the short run, result in a movement away from constructivism in classrooms.

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