Title	Beyond information pumping: Creating a constructivist e-learning environment
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Source	*Educational Technology, 42*(5), 48-54
Published by	Educational Technology Publications

Beyond Information Pumping: Creating a Constructivist E-Learning Environment

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Introduction

E-Learning is currently one of the "biggest" things in the world of training and learning. The popularity of e-Learning stems from its advantages, such as 24/7 accessibility, anytime-anywhere learning, ease of update of information, and self-paced learning. Very often, information is presented as hypertext, sometimes including hypermedia. The notion of re-usable learning objects is also gaining popularity. In this article, it is argued that simply presenting information to learners may not be the best way for e-Learning to occur, as it is making too many assumptions: the learners are motivated, the learners are able to learn independently, and the learners can transfer and apply the knowledge to real-life situations. It is proposed that to best harness the potential of Internet affordances, the definitive advantage of e-learning over learning via other media is to adopt a social constructivist approach, which is based on Vygotskian theories of learning and situated cognition.

The e-Learning Hype

If you have ever observed a group of small kids talking about the latest toy in the market, you will be amazed by the intense emotion embedded in their highly gestured conversation. It is as if the new toy is the only thing that matters in the world, and possessing it would bring them the ultimate honor in their circle of friends. E-Learning to trainers and educators is likened to the new toy (for the kids). It now seems that everybody that has something to do with training or education, whether in the corporate sectors or in educational institutions, seems to be talking about e-Learning. Many cannot wait to jump on the bandwagon to have a share of the e-learning pie, if we may mix metaphors.

But what is e-Learning? One can find dozens of definitions in magazines, periodicals, or online journals. According to the e-Learning glossary in *Learning Circuit* (ASTD, 2001), e-Learning "covers a wide set of applications and processes, such as Web-based learning, computer-based learning, virtual classrooms, and digital collaboration. It includes the delivery of content via Internet, intranet/extranet (LAN/WAN), audio- and videotape, satellite broadcast, interactive TV, and CD-ROM." In the book *Leading E-Learning* (Horton, 2001), it is defined as the "use of Internet and digital technologies to create experiences that educate our fellow human beings."

There seems to be some confusion about the definitions, but if one were to analyze it closely, there is convergence among these definitions. In the broadest sense, e-Learning is learning administered via any electronic medium—CD-ROM, video, or Internet. In practice, the dominance of Internet technology makes it the medium of choice among the electronic media.

Why is e-Learning creating such a storm? If one were to search for a reason for using e-Learning, it is not hard to find the following reasons being cited:

1. **24/7 Accessibility**
   E-Learning makes anytime, anywhere learning possible. Users can access information 24/7 (24 hours a day, 7 days a week). Most forms of media rely on physical carriers of information (e.g., books or CD-ROM), which can be used by one or a small group of users at a time. Information access via the Internet can be done anywhere and by many users as long as the users have access to the network. With the advent of technology like wireless ports, PDAs and such, anytime, anywhere accessibility becomes a reality.
2. **Ease of Update**
   For other media, such as books or CD-ROMs, to update information, one needs to make a printed document or press a CD-ROM, then distribute these media to the users. Internet connection makes possible updating of materials from the comfort of one's home, and removes the hassle of physically distributing the media.
3. **Hypermedia Delivery**
   Unlike text print in a book, which flows in a linear fashion, the WWW is a hypermedia system in which hyperlinks are used to allow more meaningful access to information based on

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related ideas. The hypermedia feature, however, is also possible in other computer-based media.

4. **Self-Paced or Self-Directed Learning**
   Unlike a classroom situation in which the instructor decides the pace of learning and instructional sequence, e-Learning allows users to learn at their own pace and in their own sequence. This is partly afforded by the hypermedia capability of the WWW.
5. **Communication and Collaboration Tools**
   The Internet opens up channels of conversation and expertise beyond physical and regional boundaries. Learners, with different levels of expertise and distributed among various geographical locations in the world, are able to learn together beyond the boundaries of classrooms.

It is for these reasons that a lot of effort has been channeled toward managing information the "e" way. To illustrate how a typical learning management system operates, imagine Alex, a university student, learning from an e-learning course. Alex first logs on to the system and is greeted by a list of courses for which he has signed up. Upon selection of a course from the list, he is brought to a page with an arrangement of icons or buttons, and probably some announcement. He can now access various course materials by clicking on these icons or buttons. Some common materials include course schedule, course information, course materials and documents, a discussion forum, assignments, online assessment, online chat, and reference links. The course materials can range from text documents to interactive tutorials. Upon completing the course content, Alex can choose to do the online assessment and obtain immediate results on his performance.

What's Wrong with Information Pumping?

Such an approach to instruction places great emphasis on facilitating learning management. Learning management may enhance the efficiency of learning; however, its effectiveness in enhancing learning is based on a few assumptions. First, the learner is assumed to be capable of self-directed learning. The learner is assumed to be able to process the information by reading the text, hypertext, or hypermedia; to search for relevant information to fill his knowledge gaps; to monitor his own understanding before taking the big test; and to confidently complete this process without personal guidance. Second, it is assumed that the learner is motivated to learn about the topic being presented. Very often, the major source of motivation is the assessment. The learner processes the information meticulously as he or she strives to achieve a better grade. Third, transfer of learning occurs naturally where the learner is able to apply what he or she has learned in a real-world context.

These assumptions may be valid for adult learners who initiate learning triggered by problems faced in the workplace. Suppose Alex has recently graduated from the university and has taken on the job of a new project manager. For him, learning about project management is imperative. Because of the demand of his job, while going through the course material, he will naturally interpret the course content in terms of his workplace context and experience. Getting a good grade in the course is relatively less important, but solving real-life problems naturally motivates him to assimilate and apply the knowledge learned.

This model, however, may break down for learners who are learning out of real-life context(s), particularly those in educational institutions. The first assumption, that of a self-directed learner, is relatively easy to solve. If a learner is lacking in self-directedness, an e-moderator or e-facilitator may provide assistance. An interactive tutorial may also help to enhance acquisition of knowledge. However, a lot more has to be done to motivate learners and to ensure transfer of learning.

In addition, although content is also easily accessible because of the Internet, we believe the effectiveness of learning is enhanced if we capitalize on the unique affordances of the Internet technology—communication and collaboration. Affordances refer to the fit between human capabilities and external objects, such as environmental supports and opportunities that make possible a given activity (Gibson, 1979; Gibson & Pick, 2000). The Internet is an ideal communication medium, which connects distributed expertise and facilitates collaboration. This feature best supports social constructivist learning, the central tenet of which is learning through social interaction and co-construction of knowledge. In other words, the assumption we have made here is that the process of learning is facilitated through *construction* rather than *information pumping.*

Understanding Constructivist Learning

Let us start by looking at some of the theoretical underpinnings of constructivist learning. The following theoretical works and positions shape the current notion of constructivism:

Constructivist learning, as advocated by Piaget (1960,1981) and Bruner (1990), posits that meaning is constructed in the mind of individuals through discovery, with a focus on the process of assimilation and accommodation of knowledge. Meaning is perceived as inseparable from one's own interpretation. Its emphasis is not in the interactions of the individual with the environment (including other social beings) but more on how the mind constructs knowledge. Learning is an active process of constructing rather than acquiring knowledge. Knowledge is not just a mental state; rather, "it is an experienced relation of things,

and it has no meaning outside of such relations" (Dewey, 1910/1981, p. 185).

More recently, the social orientations of constructivism commonly linked to Vygotsky (1978) and neo-Marxist theories of practice (e.g., Lave & Wenger, 1991) have gained wide currency. Vygotsky emphasizes the cultural influences and social context influencing learning. Vygotskian constructivism is called social constructivism because he emphasized the critical importance of interaction with people in cognitive development. Where Piagetian constructivism emphasizes cognition as an individual activity and 'in the head,' social constructivism focuses mostly on knowledge socially constructed 'in the world.'

Vygotsky's (1978) *Zone of Proximal Development* (ZPD) emphasizes his belief that learning is fundamentally a socially mediated activity. Thinking and problem solving can be placed in three categories. Some can be performed independently by the child. Others can be performed even without help. Between these two extremes are the tasks the child can perform with the help of others. These tasks fall within the ZPD. If the child uses these cognitive processes with the help of others, such as teachers, parents, and other students, they will gain skills and abilities that can be used independently later. The fundamental premise of Vygotsky's theory is that communicative acts through collaboration can be internalized. Vygotsky sees psychological tools as mediators for cognition that begin at the social level and become internalized at the individual level. In fact, Vygotsky posits that all cognition begins at the social-cultural level through the mediation of human signs and symbols. Language is a crucial 'psychological tool' mediator. If so, dialog through language becomes an important factor for internalization of meanings to take place—and thus learning.

Constructivists emphasize situating learning experiences in a real-world context—rooted in the notion of situated cognition proposed by Brown, Collins, and Duguid (1989). Brown *et al.* (1989) argue that personal experience is crucial to the construction of meaning. An idea, together with an individual's experience with that idea, is an integrated unit that constitutes the meaning of an individual understanding of that idea. Thus, experience with the idea is critical to its understanding and one's ability to use and apply the idea. Following this argument, Resnick (1987) points to the distinct differences between in-school and out-of-school experiences, and argues that decontextualization is the cause of lack of transfer in school learning. Brown, Collins, and Duguid (1989) regard learning as an enculturation process—a social process situated in the practices of a culture. Learning occurs when a person is actively engaging and participating in the practices of a culture in a community.

To summarize, constructivist learning encourages the learner to engage in the active process of meaning-construction in real-authentic problems and situations, and where learners are able to socially construct knowledge with others. Importantly, learning construction can also be facilitated through guidance by more knowledgeable peers or adults, but the responsibility and ownership for learning must be on the learner.

The above are some salient theories and perspectives that lay the foundation for many current proponents of constructivist learning. In the next section, two constructivist learning frameworks or models will be reviewed.

Constructivist Models

Perkins' Five-Facet Learning Environment

Perkins (1992) proposes a five-facet constructivist learning environment that aims at achieving the educational goals of 'retention, understanding, and active use of knowledge and skills':

1. *Information Banks.* The information bank by Perkins is our familiar information resources mentioned in the earlier section of this article. According to Perkins, it is the 'source of explicit information about topics,' and they include 'dictionaries and encyclopedia' and 'the teacher.'
2. *Symbol Pads.* The symbol pads refer to 'surfaces' that allow learners to construct and manipulate symbols. They include simple tools like a notepad to a sophisticated laptop computer.
3. *Construction Kits.* Construction kits, according to Perkins, are tools that allow the learners to manipulate and construct objects. They range from Legos, to chemical apparatus, to computer programming languages. Perkins acknowledges the similarity between construction kits and symbol pads, but emphasizes that construction kits possess prefabricated parts and processes, and thus impose certain structure during the construction of the objects.
4. *Phenomenaria.* Phenomenaria, a term coined by Perkins, refers to 'an area for the specific purpose of presenting phenomena and making them accessible to scrutiny and manipulation.' It includes laboratory chemical problems, microworlds, and simulation games.
5. *Task Managers.* Task managers set learning activities or tasks for learners, provide guidance and assistance, and offer feedback and assessment. A typical task manager is the teacher, but task managing could also include activity templates, learners, and even computers.

Perkins's model is generic to all learning environments, as he further argues that not all learning environments display all the five facets. A more

traditional didactic classroom instruction would include the teacher and text as the sources of the information banks, symbol pads like notebooks or worksheets, and the teacher as the task manager. A more constructivist learning environment, on the other hand, will place phenomenaria and construction kits at its heart. One such example is the Logo construction language by Seymour Papert (1980).

Building on the work of Piaget and Bruner, Perkins further proposes two approaches of constructivism: BIG (Beyond the Information Given) and WIG (Without the Information Given) constructivism. The BIG approach stresses providing opportunities for learners to 'work through their understanding in various ways.' This may be achieved through learning activities that provoke in-depth reflection of initial understanding and to apply and generalize the understandings. On the other hand, the WIG approach avoids direct instruction, but advocates learning in which concepts are discovered, at least in part, by the learners.

Jonassen's Constructivist Learning Environment (CLE)

Jonassen (1999) proposes a model for designing constructivist learning environment that aims to engage learners in meaning-making. The model consists of six components and three supporting strategies:

1. **Problem or Project.** At the heart of the model is the question, issue, problem, or project that serves as the focus of the learning episode. Jonassen argues that problems should drive learning, rather than starting with theories or principles and reducing problem solving to an application exercise. Using interesting, engaging, and authentic problems helps promote ownership of the problem and thus motivates the learners towards the learning goal. To achieve that, the problems should arise out of a real-life context, which is usually ill-structured, with some emergent aspects that are definable by the learners. To communicate the problems to the learners, we need to specify the problem context (the environment and community of practitioners), the problem representation, and the problem manipulation space (which provides the objects, signs, and tools for learners to manipulate with some variables in the environment).
2. **Related Cases.** Based on case-based reasoning and cognitive flexibility theories, Jonassen proposes using related cases to supplant student experience—the argument being that human knowledge is encoded as stories about past events and experience. When met with a new situation or problem, human beings tend to search their memories for related cases. In addition, related cases provide multiple representations of content that reflect the complexity of a domain knowledge. Novice learners are usually lacking in experiences in certain problem situations; providing such scaffolding is thus critical.
3. **Information Resources.** Relevant information should be provided so that the learners can understand and solve the problems, with the assumption that information makes most sense in the context of its application. Information banks and repositories should be provided in a just-in-time and learner-selectable way. Jonassen emphasizes the importance of selecting relevant and appropriate materials, including Web-based materials, with embedded hyperlinks to these materials at appropriate juncture.
4. **Cognitive Tools.** Cognitive tools refer to computer tools that engage and facilitate certain cognitive processes. They help to support the learners in performing the problem-solving tasks. Cognitive tools include visualization tools, knowledge-modeling tools, performance-support tools, and information-gathering tools.
5. **Conversation and Collaboration Tools.** Fostering a collaborative learning environment is premised on the notion of social constructivism, which emphasizes learning through collaborative construction of socially shared knowledge. A number of computer-mediated communication tools can be used to support dialog and collaboration within a community of learners, who share similar knowledge and values and are pursuing similar learning goals. Collaborative tools include simple discussion forums to scaffolded environments.
6. **Social/Contextual Support.** The social and contextual support includes readiness in physical infrastructure and training to instructors and learners. This is an important factor necessary for successful implementation of the learning activities.

In addition to the above components, Jonassen suggests three supporting strategies—modeling, coaching, and scaffolding. Modeling includes behavioral modeling of overt performance, such as showing worked examples, as well as cognitive modeling of covert intellectual processes, like articulating reason or decision-making. Coaching focuses on a learner's performance. It involves motivating learners, analyzing their performances for feedback and advice, and provoking reflection. Scaffolding refers to the systemic approach to support the learners, which includes providing frameworks to support performance and adjusting task difficulty.

Design Factors

When we consider the above two models in order to

appropriate the design considerations for e-learning, we have the following factors:

- learner(s) acting within the context of a problem (or related problems);
- problems could also be simulated environments or phenomenaria;
- cognitive tools or construction kits in order to engage in the process of solving the problem(s) or task(s);
- information resources or information banks (including case libraries) through which learners can search for knowledge;
- communication tools or conversational tools for collaboration and the co-construction of knowledge; and
- task managers and social context support, either for administrative functions or for mentorship or peer guidance.

Technology in Constructivist e-Learning Environments

To better visualize the above principles as described for constructivist learning in e-Learning, see Figure 1.

Figure 1 illustrates an individual learner working on a problem with the support of cognitive tools, information resources, case libraries, and communication tools (as suggested by Jonassen's Constructivist Learning Environment), as well as the task manager (as suggested by Perkins). All these resources and tools are afforded by e-Learning technology, such as the Internet and a learning management system. The symbol pads can be individual electronic documents, such as Microsoft Word or a shared document that the learner co-works with others. The computer or other electronic devices also function as the link to a larger community (see Figure 2).

Figure 2 shows how each learner unit is connected via networked computers. One of these can be an instructor's unit, from which the instructor will provide modeling, coaching, scaffolding, and facilitation of interactions among learners. The instructor is placed as a peripheral unit because in certain cases, some of the instructor's functions can be performed by the learners. Learners with different expertise can take turns to lead, model, coach, scaffold, and facilitate. For instance, in a Webpage design course, Alex, who has taken a course on Dreamweaver, could help to answer questions about the operation of the software. Marie, Alex's course mate, could have expertise on Java programming and would be able to assist others in this area. The contextual support, like physical infrastructure, must be in place for such interaction to occur. Contextual support may also be exhibited through a supportive organizational culture for e-Learning.

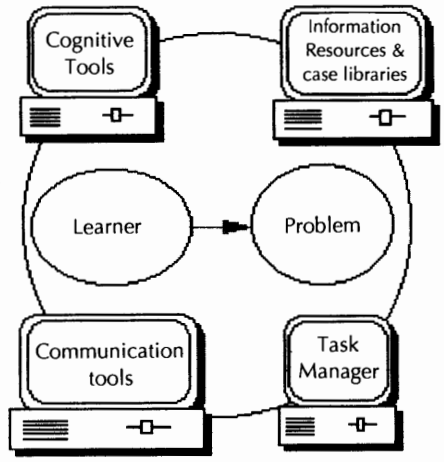

Figure 1. Individual learning supported by technology.

An Example of Constructivist e-Learning: Concrete Clinic

The first author has conceptualized a prototype of a constructivist e-Learning module together with the Department of Civil and Environmental Engineering at Pennsylvania State University. The main objective is to impart in civil engineering undergraduates, the skills in diagnosing and solving problems in the building of physical concrete structures.

The module, titled "Concrete Clinic," includes resource links, case studies, and problem-solving activities. As an example, one problem-solving activity starts with the description of a real-life concrete engineering problem together with photographs to establish the authenticity of the problems (Figure 3).

Next, the learner is prompted to diagnose the problem, followed by justification for the diagnosis. Feedback is given to the learner on the answer and the correct reasons provided (coaching). A learner who is not sure how to proceed with the diagnosis can opt for expert advice (modeling). At any time, the learner can click on the Library button that opens a new Window housing a repository of information on cement and concrete (information resources). After the concrete problem is identified, the learner will be led to the next phase of problem solving: suggesting a plausible solution to the problem. The learner can opt to study a few related cases (case libraries), which help to provide expert experience in problem solving (scaffolding). During the study of related cases, a blank space is provided (symbol pad) for the learner to type in the solution to these cases. Upon submitting the answer, an expert solution will be shown (modeling). The learner

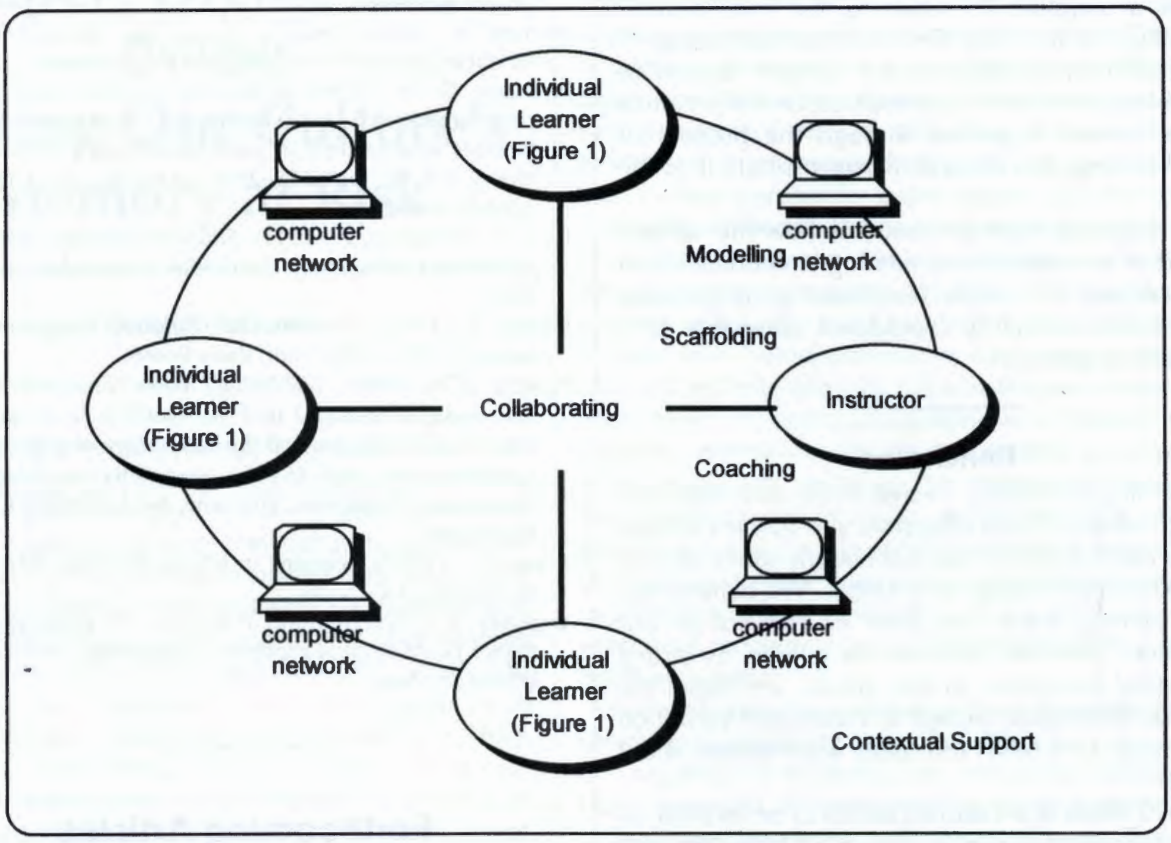

Figure 2. Learning within an e-Learning community.

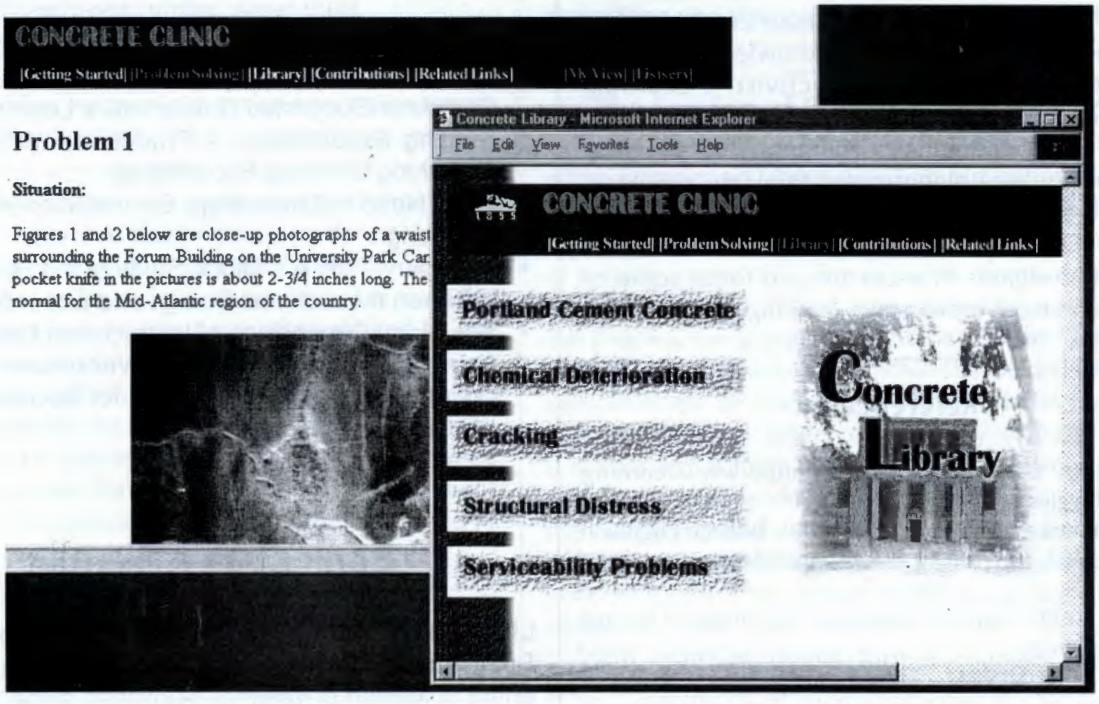

Figure 3. Screen shot of problem presentation and library in the study of concrete.

can then click on a "Final Report" button which activates a template for reporting the final solution (scaffolding). At any time, the learner can participate in a discussion by clicking on the Listserv button to communicate with peers (communication tool). Notice that the learner is guided through the process of problem solving; thus the task manager is built-in to the module.

This prototype module illustrates how the various elements of a constructivist learning environment can be actualized, in a topic (engineering of concrete structure) not ordinarily considered amenable to a constructivist approach.

Conclusion

E-Learning is creating a wave in the education and training industry. Some educators and trainers choose to jump into the stormy sea without any safety device, while others seek refuge in a harbor. We believe that the e-Learning wave can push us forward to our destination, provided that we are guided by strong pedagogical principles. In this article, we dispel the myth that information access is a sufficient condition for learning, as it holds too many assumptions about learners.

Today's thrust in e-Learning seems to be focused on the management perspective of learning rather than the process of learning itself. Management of learning includes providing user accounts, log-on interfaces, and personalization of contents. These issues are important; however, they miss the essence of learning, which is the active construction of knowledge.

We propose that a constructivist e-Learning environment captures the full essence of e-Learning by creating a rich learning environment that provides motivation, engages higher-order thinking, promotes collaborative knowledge building, and enhances transfer of learning. We hope that this article has encouraged designers of e-Learning to focus some of their efforts on these more active learning processes. □

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Forthcoming Articles

Among the articles scheduled to appear in forthcoming issues of this magazine are the following:

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- Staging Experiences: A Proposed Framework for Designing Learning Experiences.
- From Need to Ownership: Socialization into Online Teaching.
- Boundary Talk: A Cultural Study of the Relationship Between Instructional Design and Education.
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