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Abstract

An interesting conversation evolved at one of last year's Teaching of Educational Psychology's paper sessions. It centered on this issue: "How can educational psychology courses be structured to build on student understanding, allow for student exploration, and provide students access to multiple sources of information and viewpoints?" This paper describes a 3-D software based on a library metaphor. Students browse through a series of virtual rooms to explore learning, cognition, and classroom applications of educational psychology. After beta testing, the purpose of the software is to support undergraduate and graduate students as they study educational psychology and instructional design at a large midwestern university.

Authors' Note: we would like to thank Regan Richards, David Hevel, Kelly Wells, James Cooper, and Edward Williamson who made significant contributions to the development of the software. Without their dedication, expertise, and sense of humor, the Virtual Library would still be a figment of our imaginations.

The Virtual Library

According to experts in instructional design and methodology, well-designed and well-taught courses contain tightly sequenced content that becomes exemplified through direct instruction, course readings, and hands-on learning activities (Gagne, 1985; Merrill, Li, & Jones, 1990). Contemporary educational paradigms like constructivism, however, are challenging traditional instructional practice. Conventional, direct-instruction pedagogy is criticized for not providing students with contextual features, and it generally fails to provide opportunities for genuine exploration, discourse, or disagreement. Consequently, students rely on superficial, surface-level features of problems and information without abilities to apply or use knowledge (Anderson, 1990; Chi, Feltovich & Glaser, 1981; Lave, 1988; Resnick, 1987). Instead, the primary opportunity students are given to apply knowledge is through multiple choice or essay tests (Slavin, 1994).

Constructivists argue that active engagement, authentic tasks, student-centered, and exploratory learning all play central roles in learning and understanding. In other words, students learn best when they are actively engaged, direct their own learning, and explore content under study around a complex problem. Increasingly, university educators are embracing this paradigm as a model of learning and instruction (Black & Ammon, 1992; Kamii, 1985; Fosnot, 1989; Reiff, 1993; Venezky & Gong, 1993). Likewise, software developers are beginning to consider the adoption of constructivist ideals in order to promote learning (Lebow, 1993).

Our purpose was to promote learning in educational psychology and instructional design my creating a multimedia software designed around cognitively-guided theory and research; we named the software the Virtual Library (VL). Specifically, three theories (behaviorism, information processing, and constructivism) are represented in various "rooms" within the library. Students have access to movies, text, images, and animations. Also, they have opportunities to participate in interactive discussions and e-mail conversations with other students, classroom teachers, and educational psychologists. After completion, undergraduate and graduate students will use the VL as a companion to courses. Students will use the software outside of class, and class time will be spent on discussion, elaboration, and Socratic seminars. Along with serving as a learning tool, the Virtual Library will serve as a repository for student work. Upper-level students will learn about educational theory, instructional strategies, and technology by designing and creating multimedia artifacts for the VL. In other words, students will learn-by-doing, and the VL will become a show-case for student-created and designed projects. The following describes the software in detail. In the description, we summarize how research on learning and cognition influenced our thinking about designing the software and presenting various media therein.

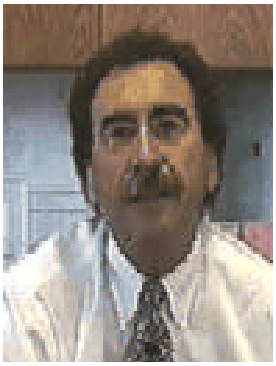
The Virtual Library

Overall, cognitive psychology has much to offer instructional practice and software design. Altogether, cognitive research and theory suggest students be provided with learning environments or tools that facilitate exploration, inquiry, and a personal construction of meaning (Fosnot, 1989; Lehrer, 1993; Papert, 1980). Likewise, cognitive researchers and theorists propose that students be provided social learning experiences where they have extended opportunity to discuss ideas with others (Gardner, 1991; Slavin, 1994). Moreover, others recommend that students become engaged in authentic problem-solving activities where students are required to generate knowledge and test their skill in a rich context (Brown, Collins, & Duguid, 1989; Glaser, Lesgold, & Lajoie, 1987; Newmann, 1991). Collectively, these ideas became the foundation for designing the Virtual Library.

A Museum Metaphor & Exploratory Learning. Exploratory learning environments are thought to help students learn because they require students to actively construct meaning as opposed to passively receiving it (Hsu, Chappelle, & Thompson, 1993; Papert, 1980). Environments that allow students access to multiple sources of information, tasks, and problems, in an order that learners prefer, and where learners are required to construct an understanding, helps to create a closer alliance between what it means to learn and classroom instruction (Kamii, 1985; Reiff, 1993; Venezky, & Gong, 1993).

Explicitly, the VL was conceptualized around a library or museum metaphor so that students may browse through a series of virtual rooms to explore and construct an understanding of research, theory, and classroom applications of educational psychology and instructional design. In this way, learners build on their background knowledge, seek out unknown information, and follow their own interests. Currently, three separate rooms comprise the library environment, and each room represents a distinct theory of learning in educational psychology and instructional design (behaviorism, information processing, and constructivism). Figure 1 depicts the behavioral room, and this room is illustrative of the type of space found in the other two rooms. Users may walk through the environment by clicking around on the screen. If they click on the right side of the screen, they will turn right. If users click in the middle of the screen, they will move forward, and so on. As users get close to specific artifacts, they may click on the artifact to receive information: clicking on the dog statue retrieves archival video of Pavlov working in his laboratory; clicking on the B.F. Skinner book on the bookshelf will open a multimedia book that contains audio tracks, movies, and even text files on poetry written by Skinner; clicking on the teacher painting will retrieve a movie where a teacher illustrates how she uses principles of behavioral management (operant conditioning) in her classroom.

Authentic Tasks. To assist students in organizing information they find, they are provided with a menu of authentic tasks that help guide their exploration and provide them with a purpose for using the software. Because it is difficult to devise one central authentic task for multiple users of varied backgrounds, an introductory interface provides students with diverse authentic tasks. In other words, in the Virtual Library, the user selects and defines his or her own mission or authentic task. The missions will loosely guide students as they interact with the software. For instance, similar to *Advise the President* (McGee & Beckwith, 1993), users may choose to "advise the dean."



Advise the Dean Mission:

"Schools and universities are restructuring classrooms in dynamic ways. Ideally, classrooms *should* be based on theoretical and empirical support derived from educational psychology and instructional design. At the end of the semester, you will meet with the Dean of the College of Education and with representatives from the state and advise them on the best possible theory (or theories of learning) and how to best translate theory into classroom practice."

Along with advising the dean, students may select other tasks or missions, including making conference presentations, conducting lectures, serving as school consultants, role-playing instructional designers, reporters, teachers, or mock debate experts:

> A public forum of experts, reporters, teachers, and parents will gather to debate whether a constructivistic philosophy should or should not be adopted by local schools. During the debate,

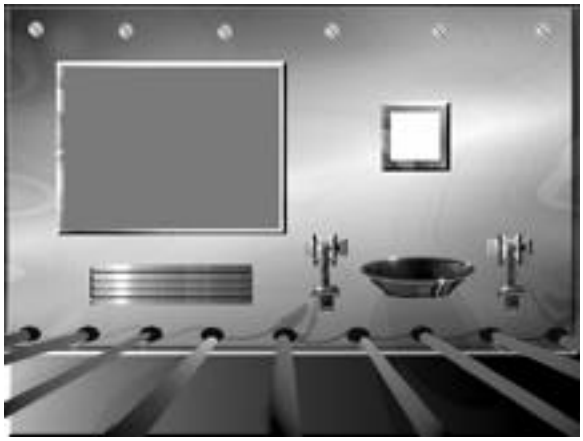
you will role-play a constructivistic, behaviorist, information processor, or you will sit on a panel of reporters, parents, and administrators.

In each mission, the student is expected to make a formal presentation to a live audience (e.g., the dean, principals, parents, administrators, on television, on the internet, etc.)

Student-Centered Learning. The VL contains a rich source of information for students to discover and use to be successful in their missions. Each room contains information about theoretical beliefs, empirical support, and implications theory has for teaching. In the loosely-structured environment, media is presented to invite student exploration, and it is represented in movies, text, animations, and game-like scenarios. Multimedia offers students several unique characteristics important for student-centered learning that a textbook or teacher cannot offer. First, multimedia offers students choices on accessing information in the form of text, audio, video, or through simulations. In other words, it becomes easy to present information in more than one way where students make choices. Dual coding theorists suggest that information presented both visually or verbally is better remembered (Clark & Pavio, 1991). To illustrate, in the VL there is archival video users may watch on Pavlovian Conditioning and or they may access a text file on the same topic. Similarly, multimedia helps students to repeatedly visit concepts not mastered, and they can sequence learning according to individual preferences as opposed to teacher selected sequences.

Along with presenting information in more than one way, multimedia helps to present information in nonlinear ways that invites students to seek out explanations. In the VL, when a user "clicks" on the photo of Watson, they hear this, "John Watson is considered to be the father of behaviorism, and he conducted his most famous experiment with Little Albert." Afterwards, the user may click the photo of "Little Albert as an Adult" to watch an animation where Albert becomes frightened at the sight of a mouse. If the user is curious about this, he or she may seek out a multimedia book on Watson to find out more on Watson's experiments with Little Albert, read a text file on one of his writings, or hear additional audios regarding his contributions to educational theory and research.

In other instances, multimedia helps to present information in visually rich and stimulating environments or in game-like scenarios. When a user clicks on Skinner, she or he tumbles into a virtual Skinner box to learn about operant conditioning (see the Figure 3 for this interface).



The Virtual Skinner Box:

"Welcome to the Virtual Skinner Box. Your task is to figure a way out ... "

{To exit the box, users need to figure out a series of lever pushes. When correct, the user is rewarded with an informational movie -- most of the movies are actual footage of B.F. working with pigeons in the 1940s; the movie provides the user with information that will eventually assist the user in exiting the box. When users make mistakes, they are given a simulated shock.}

Multiple Viewpoints, Discourse, & Dialogue. Along with exploratory learning, authentic tasks, and student-centered variables, discourse is important in learning, and this was articulated best by Vygotsky. Vygotsky (1978) suggested that cognitive development depends on social interaction, where language and discourse play central roles in cognition. According to Vygotsky, discourse is thought to provide a means for expressing ideas, asking questions, and creating categories for concepts. Discourse is thought to help student to construct hypotheses and test them against what they believe to be true. Moreover, it helps students to view knowledge and information from multiple perspectives. Conceptual growth comes when students and teachers

share different view points and understanding changes in response to new perspectives and new experiences.

In the Virtual Library, students have access to multiple points of view. In particular, many movies and other media present teachers, students, and educational psychologists who have contrasting views. The interface in Figure 4 presents users with a series of comic videos; the characters present different sides of an issue. This particular interface is presented in the VL on the kiosk in the behavioral room.

Each of the three rooms has a kiosk in a centrally located position, and information on each kiosk allows users access to analytical information about the three theories. Also, each kiosk presents examples of different theories in practice. On the behavioral kiosk, a Montessori school is presented as an example of how a developmentalist - constructivist may design a school; this is to assist the user in determining the differences between how a behaviorist would structure a school.

In addition, some of the media in the VL is connected to "outside" resources so that users may obtain multiple perspectives. In the Information Processing room, a user may access information about artificial intelligence. On user preference, he or she may seek out additional information by linking to IBM's World Wide Web (WWW) page on the recent chess match between Kasparnov and Deep Thought. Also, because several people are creating the VL and adding to it yearly, the software will contain multiple perspectives and interpretations.

Likewise, students have access to multiple points of view through a telecommunications function. Specifically, students may access a "Virtual Library Telecommunications" page on the WWW by clicking a button on the VL menu bar; the button takes the user to this URL: http://www.coe.missouri.edu/~vlibrary. On the web, users may initiate discussions, pose questions, or learn something new from various experts. Figure 5 illustrates one of the experts.

Ann Denney

Classroom Teacher: 2nd Grade

Ann Denney has been a classroom teacher for 10+ years, and she received her degree from Mizzou. Ann is currently a 2nd grade teacher at Derby Ridge Elementary in Columbia Missouri. This school has a building-wide philosophy of constructivism, and Ann enjoys talking about her classroom and school. She is especially interested in attempting to translate theory into her own classroom, and she likes facing the challenges and rewards of math investigations and reading and writing workshops.

To correspond with Ann, click here: adenney@dre.columbia.k12.mo.us

Our experts receive many different types of questions or queries, and the following illustrates a small discussion between an undergraduate and one of the experts.

Dear _____ ,

Hi, my name is Tim, and i'm currently enrolled in A205-Educational Psychology, and the topic that i wish to discuss deals with Concept Map Instruction. Now in class our instructor defined this theory as a presenter of preorganized information in an effort to help students to understand and store relationships. She then went on to give us an example with Spatial/ Hiearchial organization, which consists of the various connecting bubbles, that contain linking ideas to one another. The question that i have for you today is, can a dialectical journal be considered a form of Concept Map Instruction? In case you're not familiar with a dialectical journal allow me to tell you (i have ran into a few people who didn't exactly know what this was.) It's a form of pre-writing in which the student divides a sheet of paper into two halves, on one side of the page they write down topic words that paper is to focus on, then on the other side they write non-stop for a fixed amount of time on those particular topic words. With this, the student finds themselves digging deeper into their thoughts on the subject matter, while resolving any doubts that they may have had in their opinions, giving a backbone to their beliefs. I believe that a dialectical journal could be a form of Concept Map Instruction, if you think otherwise, or have any insight to the matter please let me know.

Take care, Tim

Hi Tim,

About your question regarding concept mapping & dialectical journaling (DJ).. from what you described, it sounds like DJ is a form of a "brain dumping" process that helps to organize thinking, especially in terms of converting thoughts and ideas into writing. It sounds like a great idea (I've never heard of it before). Likewise, I think that concept mapping can be an "organizational" tool as well. Some people use the method to organize their thoughts and ideas about complex concepts. If a person is unable to develop a concept map, say around information processing theory, then he or she does not completely understand the theory. Moreover, many information processors believe that our memories are organized in giant concept maps of interconnected ideas or related events. Try this test out for yourself....see what your "concept map" of birds looks like by naming aloud any birds that pop into your mind. It would be helpful if a friend would record your birds on paper in the order that you say them out loud.....

okay, so don't read the next part until you're done....

I would guess that your listing of birds looks something like this.... I'm guessing that you have a "cluster" of birds on your paper that are associated with these kinds of birds:

common birds exotic birds game birds
sea birds zoo birds farm birds and so on...

You probably didn't recall the clusters in this order precisely, but when you activated one "cluster" of birds, you activated another "cluster" in your memory and so on. That's partly why information processors think that parts of our memories resemble concept maps.

Okay, so much for the experiment. Thanks for your question. If you have more, you know where to find me.

Also on the telecommunications page, the user may join an on-going discussion regarding an important issue in educational psychology or instructional design. In this way, a student's perspective may change and grow as she or he interacts with others who present different views or different ways to interpret information. Some of the discussion topics that we've used thus far have included: Schools need to move beyond an information-giving model of instruction; Cooperative learning is beneficial; What are the fundamental differences between Information Processing and Behavioral theories?

Discussion

Typically, adults have tight control over pedagogy by predetermining all or most learning objectives. Then, adults construct meticulous lesson plans to deliver content in fragments across several weeks or months. Similarly, many have selected a fragmented approach in software design. Most software resembles traditional instruction because students progress through a sequential knowledge base and a hierarchical, skill-building process. This kind of instructional design is problematic for many reasons. Generally, it fails to consider the variations in student background knowledge, interests, goals, or learning style. Furthermore, when teachers pre-establish all learning objectives, including the sequence in which they will be learned, students are relegated to passive participants. Some fear that students become over-reliant on form and imposed

structure and do not learn to self-regulate (Kozma, Belzer, & Jaffe, 1993; Wood, Bruner, & Ross, 1976). Most importantly, there is scant evidence that a direct instruction approach to learning works. Direct instruction appears to be successful for basic skills instruction, especially at elementary levels in basic reading and mathematics; for other subjects and other grade levels, however, there is "less of a basis for believing that direct instruction methods will improve student learning" (Slavin, 1994, p. 286). In too many instances, past technology has not radically changed the way we teach; instead, most technology, including software, mirrors traditional instructional pedagogy (Becker, 1991).

An interesting transformation, however, is occurring and is very encouraging. Several are designing and examining alternative approaches to classroom learning and software design. Because newer educational paradigms, such as constructivism, maintain that humans assemble an individualistic understanding of the world, pre-determined learning goals with accompanying linear textbooks and lectures are not appropriate vehicles of instruction (Fosnot, 1989; Kamii, 1985). Rather, environments that allow students access to multiple sources of information, tasks, and problems, in an order that learners prefer, and where learners are required to construct an understanding, is a closer alliance between what it means to learn and classroom instruction (Reiff, 1993; Venezky, & Gong, 1993). Consider Papert's (1980) seminal work with LOGO; his attempt was to design a mechanized "turtle" that would encourage young children to learn principles of mathematics and physics in a non-linear and exploratory way -- a way that closely resembles the processes of human learning. Others have since created dynamic software by using cognitive apprenticeships, microworlds, and simulations to help students learn skills and knowledge (see Nicaise, in press). At this point in time, research on learning and cognition combined with advances in educational technology are beginning to assist researchers and educators to look at radically different ways of teaching because it provides us with the vehicle to do it differently.

The idea that research on learning and cognition could (and should) influence the way we teach and structure learning environments has established a new mindset for software designers (Lebow, 1993). Several concepts are emerging in the literature and have been outlined in this paper. These concepts should continue to serve as guidelines for instructional design and software development. In particular, this paper described how a virtual environment can support constructivist ideals in educational psychology and instructional design. The Virtual Library provides students with mechanisms for easy and unlimited entry to multiple kinds of information; it provides access to multiple interpretations of information and opportunities for social dialogue and discussion; it presents users with nonlinear learning and exploratory in a visually rich and stimulating environment; and it uses multiple authentic tasks to help users organize the information they find. After completion, undergraduate and graduate students will use the VL as a companion to courses. Students will use the software outside of class, and class time will be spent on discussion, elaboration, and Socratic seminars.

There are many high expectations regarding technology's role in modern classrooms. One expectation is that software may help create reflective students and pluralistic classrooms. Also, there is the hope that technology and cognitively-grounded software will help to create self-regulated learners who have high academic self-esteem. Moreover, there is the hope that technology will empower the learner to transfer knowledge and skills to novel situations. Research in each of these areas will help to determine if these hoped-for benefits will be realized. For our part, in the near future, our team will initiate a complex research agenda to study the Virtual Library. Some of our current questions include: Does access to classroom teachers, via e-mail, influence student learning and understanding? Do QuickTime experts, with varied views, help students think more deeply about educational psychology or instructional practice? What do students learn from the Virtual Library as compared to students in traditional lecture courses? Will students transfer learning to classroom practice?

Altogether, we think newer technologies may support learning in ways not achievable in the past; we think cognitively-guided classrooms or software can engage students in meaningful learning instead of rote practice with discrete concepts that are disconnected from purpose (Fraser, 1988; Kaput, 1992; Perkins, 1992). We also think that the role of the teacher becomes much more

interesting under constructivism because teachers create environments where students are encouraged to think and explore.

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