ICUS Viewpoint

Designing for Learning: The Pursuit of Well-structured Content

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How do you make course content really accessible to your students? Just as being an expert in your discipline is not by itself a guarantee of good pedagogy, your best-laid technology plans might miss the mark if they are not fine-tuned to the content you wish to present. And the best technology strategies benefit from semantically clear, structured content. Here, Judith Boettcher takes a look at the characteristics of "well-structured content" as it relates to the design of instructional technology resources.

With the emergence of the Web as a new space for instruction, the focus of most analyses of teaching and learning has been on process—overhauling what faculty and students are doing within the learning experience. The organization of what is being taught and its availability in various formats—the structure of the course content—has received much less attention.

Meanwhile, content development has certainly not been neglected. Digital libraries, national content projects such as MERLOT (www.merlot.org), and the work by the W3C on Web accessibility (www.w3.org/WAI/Resources/) are all efforts that foster the evolution of standards and tools for interoperability and easy access to content resources. There is clearly a trend toward further development of knowledge repositories within the disciplines.

But I think it is time now for a renewed emphasis on content resources for learning, along with increased efforts to make course content efficient and effective for students—in other words, well-structured content.

The Meaning of Well-Structured Content

The dictionary definition of the word "structure" is useful. The basic definition of structure is "the result of the action of building or constructing." This definition links well to the currently favored learning theory of constructivism.

A more elaborate definition of structure is "something arranged in a definite pattern of organization." This definition suggests one of the desirable characteristics of well-structured learning content. That is, content for which an organization is clearly visible and in which concepts are presented clearly and precisely.

Course content—the material to be learned or studied—is one of the four core components of the learning experience. The other three are the *teaching*, the *learner*, and the *environmental* components.

Consider the relationship of well-structured content to the design of an online course. Online learning based on well-structured content impacts the identification, selection, and development of course content in three ways:

- Content must be semantically well-structured for instruction; this corresponds to the *teaching* component of the learning experience
- Content must be a good fit or well-structured for a particular student; this corresponds to the *learner* component of the learning experience
- Content must be technologically well structured; this corresponds to the *environmental* component of the learning experience

Note that the meaning of well-structured content goes well beyond the dictionary definitions of structure. It includes the nuances of interaction with the other three components of the learning experience—teaching, learner, and environmental.

Principles of Designing for Learning

Before delving more deeply into the characteristics of well-structured content for digital learning resources, let's review a few basic principles. A core principle of designing for learning is that existing knowledge structures in the brains of faculty and students are different. A student approaching a discipline such as physics, psychology, or biology for the first time will likely have few core concepts, principles, or facts to build on. At this first approach to a subject, students' thought processes might be compared to the tundra, a bare and cold landscape. The students' brains might have other areas with rich growths, but in the area of physics, their brain space might be called Tundra Territory.

But the discipline knowledge of the physics faculty, at least in the area of physics, might be comparable to jungles—rich, dense growths representing complex structures of knowledge, concepts, principles, applications, and problems. The lectures by physics faculty to the students in large undergraduate courses might be described as "Where the Tundra Brains meet the Jungle Brain."

Research into the differences in the knowledge structures in the minds of students and faculty has a long tradition in cognitive research, studying the distinctions between the knowledge structures and behaviors of novices and the knowledge structures and behaviors of experts. Well-structured content can figuratively warm the landscape of the mind and support the building of foundations for complex knowledge structures.

Multi-Modal Learning Resources

A recognized principle in educational research that works well with the notion of well-structured content and technology use is that efficient learning can be facilitated with sensory input. This includes multi-modal experiences, incorporating multiple senses. Fortunately, the current ready availability of multimedia resources makes designing for learning easier than ever.

Well-structured content can make the "jungle" of concepts, rules, and principles more readily learned by students. Multimedia resources, such as animations, simulations, and microworlds encourage student involvement and increase sensory input. Dialoguing online—with other students, with faculty, and with other online resources—also increases sensory inputs.

In addition to being well-structured semantically, content resources ideally fit student goals, readiness, and the individual's current preferred learning environment.
Some students will come to a particular discipline with rich knowledge structures of their own, but still sparse in comparison to the faculty. For faculty, this means identifying and selecting a rich set of resources that may meet the needs of many students. Nishikant Sonwalker (Syllabus, November 2001) suggests the selection and identification of many sets of resources, providing multiple paths through a course.

Studying a Subject versus Taking a Course

I was reminded of the importance of content recently when I was chatting with a new college graduate. Her new position involved work with physics materials, so I asked her if she had studied physics in college. She replied quickly and emphatically, "Oh, no, I didn't study physics. I did take a couple of physics courses, but I didn't study physics!"

A curious response! Why would this graduate make a distinction between studying a subject and taking a course? In taking a course, was she describing a learning experience that might have covered content but resulted in few knowledge structures in her memory. And she was well aware of that lack of structure. Might better-structured content have helped to ensure the development of a lasting knowledge of physics?

A student who has successfully earned a grade by "taking the course" might have knowledge structures that were created and linked to each other, but not grounded. These knowledge structures might have been suspended in mid-air, inaccessible after being temporarily constructed for testing purposes. Continuing our climate metaphor, the student essentially created a climate that was temporarily nurturing of isolated knowledge facts, but without integration into other knowledge structures, the learning was lost.

Characteristics of Digital Learning Resources

In designing an online course, a course with online components, or a course that includes digital resources, an instructor makes a host of decisions about the goals and framework, as well as identifying and selecting content. In selecting content, the instructor defines the parameters for the breadth and depth of the course and the expectations of students.
Developing knowledge structures that survive a course and provide transferable knowledge and skills generally requires different types of content. While there are many hierarchies of content types, the simplest paradigm of content has three levels: (1) core concepts and principles, (2) well-structured problems with known solutions and (3) less- structured, complex problems without known solutions. Below are some guidelines for selecting well-structured content and incorporating new digital media resources within these three levels.

Level one: core concepts and principles

At this content level, a faculty designer identifies content that:

- Provides descriptions of core concepts dynamically using visual, audio, and graphic illustrations
- Provides animations that involve the students interacting with the resource and rehearsing processes
- Demonstrates relationships among core concepts, such as concept maps
- Provides clustering and chunking of information
- Reveals relationships and patterns
- Reveals differentiations and distinctions among concepts
- Links core concept knowledge with current happenings

Level two: well-structured problems with known solutions

At this content level, a faculty designer identifies content that:

- Presents consistent elements of the problem sets to the students
- Reveals patterns inherent to the problems
- Reveals sources and types of knowledge that contribute to problem solutions
- Engages the learner in the solutions, gradually increasing the complexity of the applied rules and principles
- Uses simulations that chunk and cluster the elements of the solutions

Level three: less-structured, complex problems without known solutions

At this content level, a faculty designer identifies content that:

- Provides complex scenarios, such as Harvard case studies
- Engages the learners in solving problems where neither the elements or the solutions are known
- Provides simulations of complex interactions
- Provides real-world problems such as those worked on in engineering and applied disciplines
- Provides opportunities for dialogues with experts on real-life problems
- Uses case studies and problem-based learning

Level three, "less-structured" problems without known solutions maps well to more advanced students, who can build on knowledge structures already in place and apply their creativity to problem-based learning sets. Ideally, students involved in level-three problems will already have well-constructed knowledge, resulting from previously effective engagement with highly structured learning modules.

Digital content resources in support of learning need to map to students' needs and to students' readiness. Supporting the development of lasting knowledge structures continues to be art as well as science.

What is Different about Digital Content?

Given the richness of the digital resources available, we now think about content differently. Because content is digital, it is no longer bounded by space and less and less bound by format. Because content is digital, it may be combined and recombined. Because content is digital, it can draw on the combined power of graphics, animations, audio, and video. And because content is digital, it is easier for students to become creators of content that is custom made for the growing and nurturing of the knowledge structures in their own minds—to help them move from the Tundra Territory to the Garden State.

The development of course content is increasingly the work of artists, in particular those faculty who think visually. Edward Tufte, the author of seminal books on the display of graphic information, said it this way, "To envision information—and what bright and splendid visions can result—is to work at the intersection of image, word, number, art."

Well-Structured Content: Coming to You Soon via XML

One of the emerging content standards is that of XML, eXtensible Markup Language. Well-structured content is what designers have when they use XML to mark up content.

XML is complementary to the HTML standard. Jeff Jones (www.swynk.com/friends/jones/articles/xml_101.asp) used the following analogy to describe the difference between XML and HTML: XML is to defining information as HTML is to displaying information. He goes on to note that while XML and HTML both are text-based and both use tags, elements, and attributes, XML allows users to structure and define the information in their documents. Additionally, XML is a meta-language that allows users to create their own tags, elements, and attributes as necessary.

What's powerful for designers of today's online learning environments is that the same XML document can be displayed in a variety of formats, such as HTML, MS Word, Adobe PDF, or text. Easy portability to handheld devices is also on the horizon. XML is the future for describing, manipulating, and transmitting data. The W3C (www.w3c.org/XML/) is the place to start learning about XML and its design roles for content.

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