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VUE: A CONCEPT MAPPING TOOL FOR DIGITAL CONTENT

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Abstract. The Visual Understanding Environment (VUE) is a concept mapping tool that enables faculty and students to successfully integrate digital resources into their teaching and learning. VUE provides a visual environment for structuring, presenting, and sharing digital information and an OKI-compliant OSID implementation for connecting to FEDORA-based digital repositories. Using VUE, faculty and students can design concept maps of digital resources drawing from digital repositories, local files and the web. The resulting concept maps can then be exchanged with others or stored in repository. This paper presents the educational foundations of VUE and the underlying architecture that enables transforming content into concepts.

1 Introduction

The availability of digital information for teaching and learning has grown exponentially over the past decade. Valuable collections of digital resources have been developed by universities, government agencies, for and not-for profit companies as well as motivated individuals that touch upon nearly every academic discipline. As the availability of digital information has increased, so has the need for tools to help both faculty and students effectively select, organize and integrate these electronic resources in pursuit of their teaching and learning objectives. While there exists today a number of tools designed to organize digital content in support of traditional course-like structures (e.g. BlackBoard, WebCT, etc.), these technologies lack both the flexibility and responsiveness required to support critical and creative thinking with digital resources (Kahle, 2003). These tools' simple mode of presenting digital resources as a static selection of links organized hierarchically may serve to communicate the structure of a course or lecture at a very high level, but this approach does not support the type of meaningful exploration and content manipulation necessary to help students construct important connections between digital resources and the ideas they represent.

On the other hand, concept maps have been a part of the constructivist landscape of education since the early 1980's and research has demonstrated that concept maps are superb tools for facilitating learning (Novak, 1991). Concept-mapping software such as CmapTools[1] developed by the Institute for Human and Machine Cognitiono and Inspiration[2] have been used extensively by teachers. While these and other products share a number of common features, they lack important functionality necessary to maximize the curricular uses of digital library content. VUE, developed by Academic Technology of Tufts University, is a concept mapping application that facilitates structuring and semantically connecting electronic content drawn from file systems, the World Wide Web or a digital repository.

In this paper the educational foundations that VUE is built on are described. The architecture that enables transformation of content from digital libraries to concept map is presented. The process of creating concept maps is described.

2 Educational Foundations of VUE

Advances in understanding the learning process lead to novel approaches to instructional and educational technology design. As educators, psychologists, and cognitive scientists, among others, develop new insights into the nature of learning, developers of educational technology are challenged to design and engineer software that leverages and translates these learning theories into effective practice. Two prominent theories of learning underlie VUE and the use of concept maps more generally for teaching and learning: constructivism and individual differences.

[1] http://cmap.ihmc.us/
[2] http://www.inspiration.com/

2.1 Constructivism and Active Learning

It is widely accepted by educators and well-established in research conducted by educational psychologists (e.g. Piaget, 1970; Bruner, 1960; Duffy, 1996) that learning occurs best when students are actively engaged in constructing their own knowledge. This theory of learning, called Constructivism, suggests that instructional approaches and tools that place students in a solely passive role, one of receiving static information rather than supporting their construction of new understandings from information, are of limited effectiveness. Curriculum and supporting technologies that encourage or scaffold students' active exploration, manipulation and construction of content and connections among ideas have had a positive impact on information retention and the ability to transfer this knowledge to new situations (Hyde, 1973; Schwartz, 1995). Implicit in constructivism is the idea that learning should engage students as active participants in the structuring and re-structuring of information. By encouraging students to establish their own connections between materials and/or permitting them to add additional resources to concept maps, students can personalize the original curricular presentation and better relate new information to pre-existing knowledge.

2.2 Accommodating Individual Differences

Research in cognitive and educational psychology as well as in the field of neuroscience reveals the important role that both individual differences and shared cognitive abilities among humans play in learning. In the information-processing model of memory forwarded by Baddeley & Hitch (1974), working memory plays a critical role in processing new information and relating it to preexisting knowledge drawn from long-term memory. Memory experiments conducted by Miller (1956) demonstrated that humans are capable of holding only a limited amount of information in working memory, about seven plus or minus two distinct units. The amount of online curricular information has increased tremendously over past decade. There is a great need for tools that manage digital information within educational contexts without overloading human working memory capacity.

In addition to general cognitive capacity, there are also significant cognitive differences among people that influence their approach to learning (Rose, 2002). While some students prefer to study textual outlines and narratives to grasp an understanding of a specific topic, other students prefer pictorial forms of representation to help ground the ideas.

3 VUE: A Concept Mapping Tool

To address the needs of faculty and students in organizing content from digital resources VUE was developed. VUE is a concept mapping application designed as an integrated digital library application (Kumar, 2005). It allows users to search, browse, retrieve content from digital repositories, and upload resources into these systems. It provides a means for users to construct clear pathways through the resources linked together on a concept map and the ability to control the sequence in which resources are viewed. A complex map of linked resources can be made more accessible to domain novices by offering explicit guidance or a single set of resources that takes on multiple meanings depending upon which pathways are created. It can provide alternative representations of digital collections and curricular materials and the means by which these can be organized into personally meaningful structures. The modular architecture of VUE along with flexible interface to access and present content eases the process of access content and creating concept Map

4 The Architecture that transforms content to concepts

Simple modular approach was used to develop VUE and the code is organized based on the functionality it provides. It contains flexible set of interfaces for mapping, which contain methods that provide basic operations that are performed on concept maps and has implementations to render them. These mapping interfaces are supported by OKI OSID (Coppeto, 2005) implementations which provide access to digital repositories as shown in Figure 1. The default version of VUE comes with OSID implementations to access local drives, perform search, connect to Fedora (Staples, 2000) based digital repositories while users can acquire additional OSIDs from the providers.

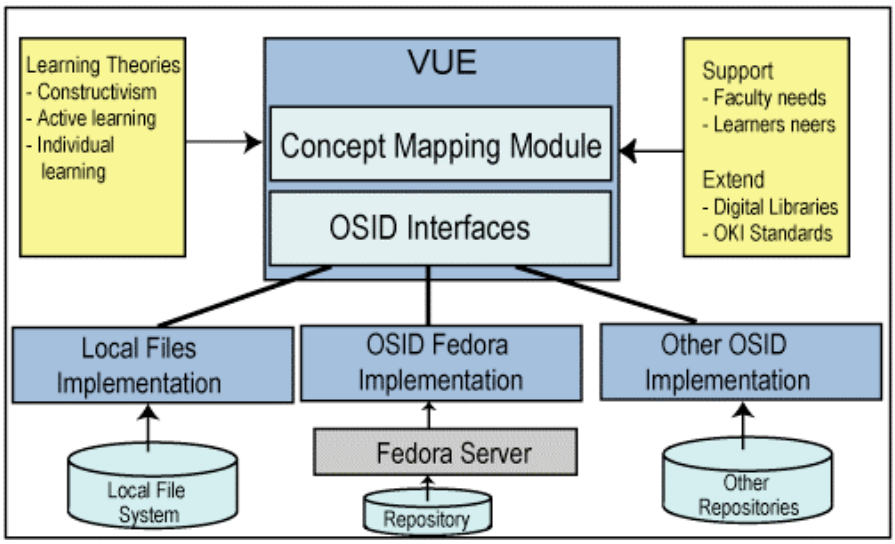

Figure 1. Architecture of VUE

5 Creating Concept Maps in VUE

VUE provides a rich suite of *tools* and *windows* that enables users to create concept maps using the content they can access. A *window* is used to display or interact with concept map or content while a *tool* allows actions to be performed. VUE not only includes basic set of tools for creating elements of concept maps such as nodes and links but also tools to inspect and organize them with the content.

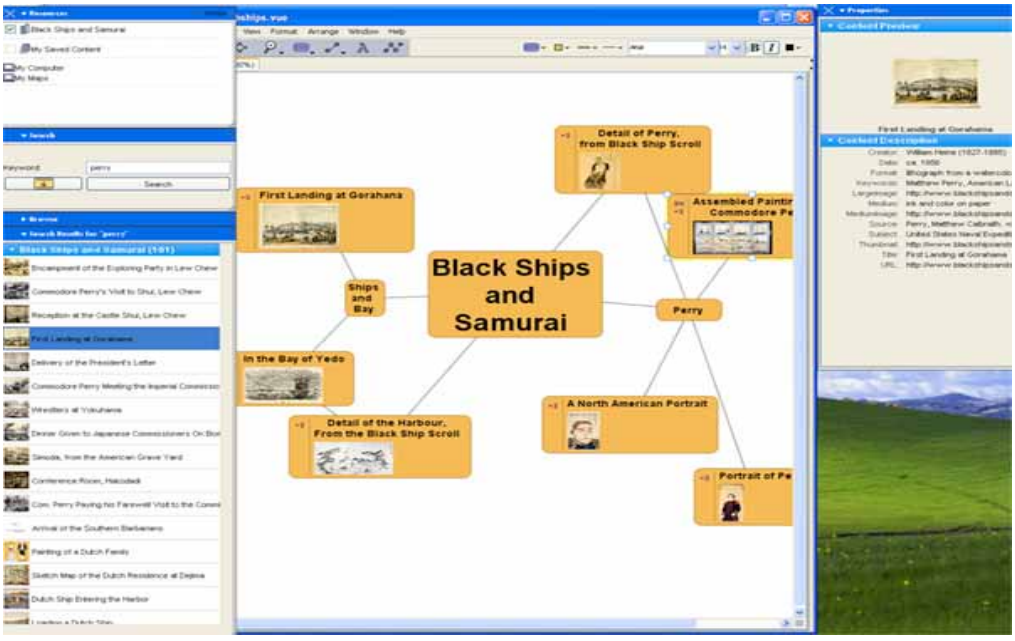

Figure 2. Concept map in VUE

Figure 2 shows a concept map in VUE along with the tools and windows that enable creation and searching repository. The figure displays results of a search on left, the concept map in the center and information of content with preview and its metadata on the right.

Faculty and students can use the content on their computer, the content they find on the web or material from digital repositories to create concept maps. Access to several repositories that provide content comes with the default

installation of VUE and additional repository OSID implementations can be acquired from providers. Content can be discovered by performing simple or advanced searches on specific resource or a collection of resources. The resulting content can then be simply dragged to create a node in the concept map. The metadata and other functionality provided by the repository for the content become automatically available in VUE, thus providing content in entirety instead of fragment.

6 Summary

VUE is a concept mapping tool based on educational foundations that supports the needs of teachers and learners. A rich set of tools to create concept maps using content from on local machines and standard digital repositories is provided. The repository architecture based interoperable OKI standards allows access to newer repositories by developing OSID implementations. Thus, VUE transforms the process of creating concept maps to building content maps.

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References

Baddeley, A. D., and Hitch, G. (1974). Working memory. In G. A. Bower (Ed.), The psychology of learning and motivation, Vol. 8. New York: Academic Press.

Bruner, J. (1960). The Process of Education. Cambridge, MA: Harvard University Press.

Coppeto, T & Sim, Service Oriented Architectures with OKI, JA-SIG, 2005.

Duffy, T. & Cunningham, D. (1996). Constructivism: Implications for the Design and Delivery of Instruction. . In D. Jonassen (Ed.), Handbook of Research for Educational Communications and Technology. New York: Macmillan Press.Hyde, T. S. & Jenkins, J. J. (1973). Recall for words as a function of semantic, graphic, and syntactic orienting tasks. Journal of Verbal Learning and Verbal Behavior, 12, 471-480.

Kahle, D, Kumar, A & Saigal, R. Visual Understanding Environment, Syllabus Fall Conference 2003.

Kumar, A & Saigal, R, Visual Understanding Environment, JCDL 2005, 413.

Miller, G. (1956). The magical number seven plus or minus two: Some limits on our capacity for processing information. Psychological Review, 63, 81-97.

Novak, J. D. & Wandersee, J. (1991). Coeditors, Special Issue on Concept Mapping of Journal of Research in Science Teaching, 28, 10.

Paiget, J. (1970). The Science of Education and the Psychology of the Child. NY: Grossman.Chakrabarti, S., Dom, B., Gibson, D., Kleinberg, J., Raghavan, P., & Rajagopalan, S. (1998). Automatic Resource List Compilation by Analyzing Hyperlink Structure and Associated Text. Paper presented at the 7th International World Wide Web Conference.

Rose, D. & Meyer, A. (2002). Teaching Every Student in the Digital Age: Universal Design for Learning. Alexandria, VA: ASCD.

Schwartz, J. (1995). Shuttling between the particular and the general. Reflections on the role of conjecture and hypothesis in the generation of knowledge in science and mathematics. In D. Perkins, J. Schwartz, West, & S. Wiske (Eds.), Software goes to school: Teaching for understanding with new technologies. NY: Oxford University Press.

Staples, T & Wayland R. Virginia Dons Fedora: A Prototype for Digital Repository. D-Lib Magazine 6, 7/8.