Enhancing Learner-Centred Design of Hypermedia Artefacts Through Cognitive and Affective Indicators

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Abstract: This paper discusses some issues and research findings of the project we call UNIBASE. In order to improve the learning processes through hypermedia technology, we investigated the role of cognitive mapping and the application of certain cognitive ambiguities and breakdowns. The addition of clear learning goals, explicitly expressed through cognitive mapping tools, allowed students to acquire the right knowledge and helped them adopt a productive strategy. Complementary to this elicitation process, video information embedded in hypermedia learning environments was used to increase the levels of attention and motivation, using devices such as movement, novelty and appeal. Our aims were to explore and develop the application of innovative hypermedia artefacts.

1. Introduction

The challenges ahead are usually identified with changes in how the learning experience is delivered, changes in who is delivering the learning experience, and changes in the role of the learner as part of a target population. Radical changes have already taken place in the latter and it seems reasonable to acknowledge that a new pedagogical approach is needed to cope with the arrival of a new generation of potential students. We can describe this change as a shift from a “drill generation” to a “play generation”. Somebody already called this new target-group the “playstation” generation.

To cope with these radical changes, digital technology is being increasingly used to create new learning artefacts. At the heart of this technology is the "system" perspective, as proposed by Davenport (1997). Input and output devices serve as surrogate extensions of our senses, providing connectivity to the world. Computers and networks bear some correspondence to our own brains and nervous systems. When connected together into a system, these devices enable the digital creation of systemic worlds and scenarios. The learner’s involvement becomes active and conversational, rather than passively receptive, and leads to the co-construction of meaning.

The UNIBASE project[1] aims were to explore and develop the application of innovative hypermedia artefacts. This paper discusses some issues and research findings of the project. The research activities and design experiments have been carried out with a group of 16 students, whose task was to prepare conceptual maps and hyperspaces, using a particular type of mapping software[2] with editing and

[1] Designed and carried out by Universidade Aberta (Open University in Portugal) and the Informatics Department of the University of Lisbon, Portugal.
[2] MindManager™ (www.mindman.com)

communication tools. A group of instructional designers also participated in the design of an experimental prototype for the Web, using knowledge mapping in the same way as the students did. These activities were embedded in realistic and relevant contexts with rich audio-visual representations and real-world data.

2. Facing the Problem

What learning activities can be supported by hypermedia artefacts? What are the actual cognitive and affective strengths of hypermedia? How do we design for this medium? Much has been said about the potential for interactive learning sustained by the "right" design of hypermedia in systems such as the World Wide Web. But when designers attempt to give choices to the user, as to how to proceed, options seem often to be unengaging and ineffective. A clear sense of the experiential and reflective modes (Norman, 1993) that should support such design efforts is not attained by the users/learners. However, the human mind seems to work like the World Wide Web, in a dynamic, creative, fractal and unpredictable way.

The problem we want to address can be summarised as follows: which combination(s) of interaction processes, authoring functionality and synergy between complementary elements of multimedia information can improve learning in a learner-centred educational environment? Once an author or designer abandons the notion of total control over the learning material and, instead, engages the audience in a process of co-construction, he discovers that a more fundamental question surfaces: can the learning material become organic, adaptive, and generative?

Our approach has favoured the mapping of knowledge and the application of certain cognitive ambiguities and breakdowns, in order to improve the learning processes. The addition of clear learning goals, explicitly expressed through cognitive mapping tools, allowed students to acquire the right knowledge and helped them adopt a productive strategy. Complementary to this elicitation process, video information embedded in hypermedia learning environments was used to increase the levels of attention and motivation, using devices such as movement, novelty and appeal.

3. The use of Reference Models

An adequate usage of reference or mental models, for instance as concept maps or mind maps, stimulates and facilitates the recognition and transfer of information. Basically, we strive to develop mental reference models that are meaningful organisations of information in our brains. Adequate usage of these reference models suggests that we use, for example, meaningful sounds, pictures and graphics to express ideas.

Schadé, cited by Hoogeven (1997), argues that if reference images are added to text, the understanding of a story is about 75% faster than if we are confronted with a text only story. He also hypothesises that by using reference models, innate or acquired in our early childhood, text and picture stories are stored faster and more efficiently in our long-term memory than text-only stories. He states that people tend to remember 25-35% more of a text and pictures story than of a text only story.

The use of reference models is not exclusive to educational practice; it is a well-accepted marketing technique to use basic reference pictures and sounds to improve advertisements and commercials. Often family scenes, romantic environments, status symbols, attractive women and responsible men are weaned into the marketing material. We assume that an adequate use of reference models is an important variable with regard to an effective learner-centred design process.

4. The Role of Audio-Video

The integration of "raw" audio-visual information with the learner's knowledge structure may facilitate retention and retrieval. Training learners "to transform complex visual images (i.e., to analyse, describe, categorise them) can provide an important link between visual and verbal storage and retrieval." (Kozma, 1986, p.16). This has been implemented in UNIBASE by means of cognitive mapping devices that

support the integration of audio-video segments. The final result could be easily published as a hypermedia structure.

Hyperlinks could be mouse-clicked by the learner to play short narrative explanations or video clips. It was recognised by students and designers participating in our experiments that one of video's greatest strengths is the power to generate attitudes and emotions as no other medium can. According to Anderson (1983, p.72): "It is an excellent tool for displaying affective information." The affective domain is concerned with the learner's reception and responses to the stimuli presented. Furthering this idea Azarmsa (1996, p. 39) identifies five categories that describe the levels of this domain: (a) receiving, (b) responding, (c) valuing, (d) organisation of values, and (e) internalisation, which is characterised by the learner holding a particular value or set of values.

To enhance the learner involvement in the initial stages, we had to find means to engage the learner in novel and interesting ways. Rather than just trying to simulate existing reality on the computer screen, or trying to create a "virtual reality", we found that it is far more sustainable to create a new experience for the viewer with simple means. In the past, microworlds have been created to provide an entirely new framework for the learner to explore, but today the Web can already provide plenty of worlds to interact with. According to *Cognitive Flexibility Theory* (Spiro and Jengh, 1990), learners are able to spontaneously restructure their knowledge in many ways as they chart their courses through the hypermedia material. So, we constructed artefacts - designated *knowledge hyperscapes* (Bidarra and Guimarães, 1999) initiated by the instructor and further developed by the students in an organic, adaptive and generative manner (see figure 1).

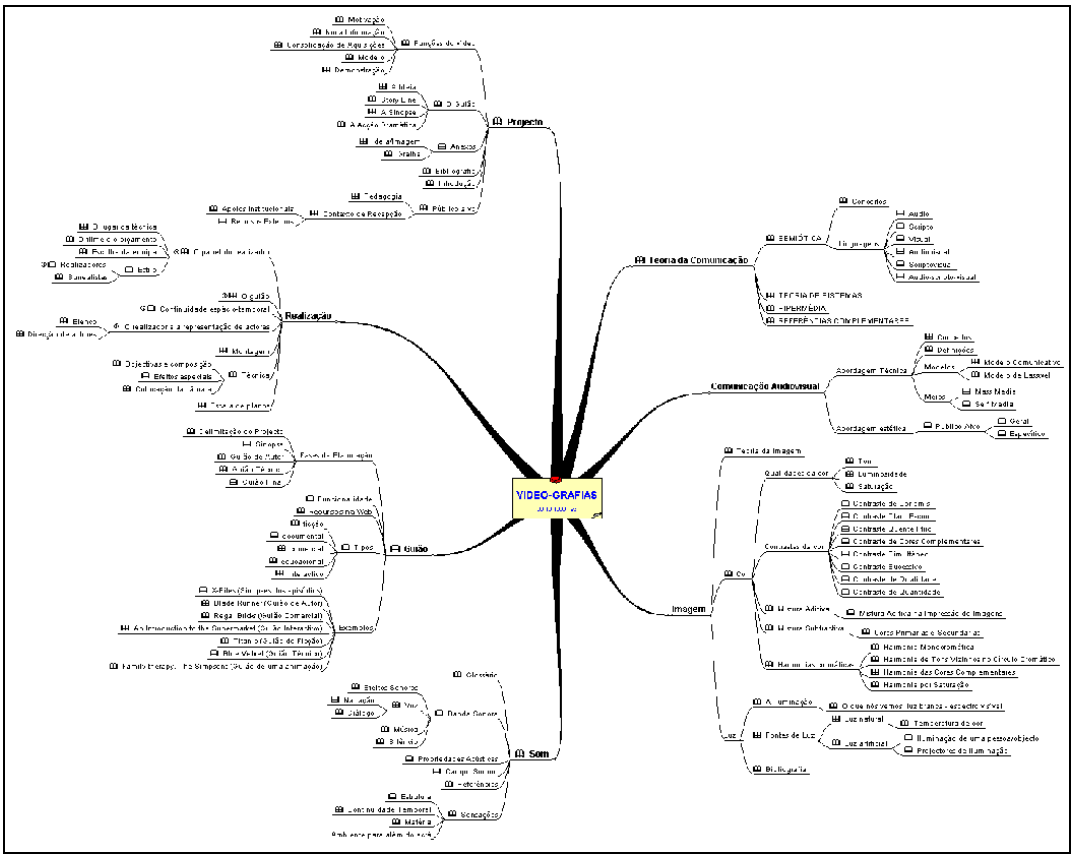

Figure 1. Map representing the hypermedia structure of the site produced.

5. Hypervideo Mechanisms as Authoring and Learning Tools

Constructivists have argued strongly for the need of authentic learning experiences and video is an appropriate tool to support this. Video clips can greatly enhance the authenticity of a computer based learning environment (Boyle, 1997). However, for a system to allow learner reflection, it must have a compositional and representational medium that affords adding new representations, modifying and manipulating old ones, and perform comparisons (Norman, 1993). Reflection also requires the time and ability to elaborate upon and compare ideas. The medium must afford the time for reflection. In this sense, broadcast television cannot augment human reflection, it does not afford composition or the time to reflect. However, television and video, when properly constructed, can be a powerful tool for reflection. If the user can select what is to be seen and control the pace of the material, and it is easy to go back and forth, to stop, to make annotations, to compare and to relate to other materials.

Effective reflection requires some structure and organisation (Norman, 1993). Structuring and organisation of information is the main issue in hypermedia. However, being multimedia is not enough for a system to be *truly* hypermedia. Different media can be used purely as illustration in a system where links are restricted to text. Hypervideo refers to the integration of video in *truly* hypermedia documents. True integration of video requires a more powerful hypermedia model, taking into account its spatial and temporal dimensions, defining the semantic structures and mechanisms for linking video, finding new concepts of navigational support, and taking into account the aesthetic and rhetoric aspects of integrating several media in hypermedia (Chambel, 1999a).

The design rationale we adopted for the educational artefacts being developed, in the context of the UNIBASE project, is based on the notion that the integration of basic elements of information must explore the cognitive bias of the different materials and create added value through adequate bridges between those elements. Effective integration must be sought by allowing the learner to exercise the "natural" cognitive attitude, while inducing proactive "breakdowns" (Winograd, 1986) that trigger reflection processes (Norman, 1993). On a video based material, such as the one we are proposing, this means letting the user enjoy and absorb the video information in very much the same way as it is currently "consumed" in the television type of interaction. On the other hand, as this type of information processing is essentially experiential, the hypervideo environment must be designed to involve the user in such a way that he is led to "stop, think, and correlate" different types of information.

Hypervideo mechanisms are therefore the basic tools for the purposeful and directed integration of video information in learning environments (Chambel, 1999b). In this context, we developed a model and some tools for hypervideo support on the Web (Chambel, 1999a), as extensions to HTML and existing Web tools, that are being used to integrate video in the UNIBASE hypermedia learning environment.

6. Experience with Learners

It is assumed that technologies like interactive multimedia help students to form rich representations of learning events and promote deeper understandings. However, this does not happen by simply adding more information and more (rich) media. We also assume that students learn in very different ways and we expect them to be able to recognise relevant domain information and be able to process it at some depth.

In our experiments, learners used their natural language to argue, question, and make connections to other subjects, other units of study, and their own experience. Many explained the course of the learned events and worked out a knowledge map. Some learners also displayed their understandings by means other than words. They also created new situations, produced images and short videos and represented the theme as a hypermedia production. Finally, they published their work on the World Wide Web (see http://www.univ-ab.pt/~bidarra/hyperscapes).

The experimental set-up was based on a group of 16 students following a course on *Video Pedagogy and Technology* in a master's programme on *Multimedia Communication*. Their previous experience included teaching for at least one year and Internet common usage skills. They were given a basic conceptual map, with relevant knowledge for the course, which they had to explore and develop further, both in class and online. They were encouraged to proceed from (non-linear) thinking to (non-linear) authoring of *knowledge hyperscapes*.

Our experimental goals were:

- to examine the use of hypermedia and communication tools in their work;
- to investigate the effectiveness of the hypermedia/Web environment that we set up;
- to find ways of improving the usability of hypermedia learning interfaces.

Data on the interactions was gathered by means of direct observation, video recordings, screen capture. These were later interpreted and checked against the evaluation of individual portfolios. Final assessment of the students was accomplished via work portfolios and a final (individual or group) project. Overall, the results were very encouraging when compared with previous years.

7. Conclusions

The approach to build an effective learner-centred system was to collect descriptive, qualitative information on complex real work settings. This required research tools that were capable of examining interaction with the hypermedia environment and also interaction within the surrounding social system. The gathered data was to be later interpreted and integrated into the design process.

Our findings suggest that:

- User control and interactivity are very important. Students appreciated the freedom to access and integrate different resources, to build new materials as hypermedia productions, and to respond to challenges, creating new situations and working out their own knowledge maps.

- The ability to integrate video in hyperdocuments was also an important feature, especially in the context of the *Video Pedagogy and Technology* course, where it could be used to illustrate and demonstrate the concepts being taught and learned, in an integrated manner.

- Constructivist activities were very motivating to the majority of students and MindManager™ software was easily mastered. Precise focus on the objectives was attained by workgroups without wasting time “playing around” with the software.

- User acceptance increases, if tools for interaction, problem formulation, design and system building are supported by reliable information about the needs and desires of potential users and the setting in which systems are to be used.

- However, students are not prepared to contribute themselves and reflect on the main issues, if there is no previous experience with the software tools that enable it. Introductory information, preparation classes or online help are necessary.

- Guidance on the thematic criss-crossing of the subject domain is a must. Students get easily lost if there is no tutor or expert support, no matter the access they have to the Internet and external knowledge bases.

The formal features of our instructional program, especially the video component, could be seen to exert a great influence on the affective domain of the learners. However, we assumed that it was the responsibility of the instructional developer to stimulate the learner to such a degree that higher levels of involvement were reached. We think that the powerful affective attribute of video needs to be explored further.

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