1. Introduction

Educators try to develop the capacity of reflection in the students and to guide classroom work by means of an effective and participatory methodology. In this reflection-action process, conceptual mappings (CMs), introduced by Novak, appear as a technique based on Ausubel’s [Aus78] significant learning model. A CM is an schematic resource aiming at the representation of significant relations between concepts [Nov 84].

A CM is a graphical representation of the abstraction of a subject or concept. Such concept is defined from other relevant concepts and from the relations existing between them.

Conceptual mappings’ design is sometimes hindered when its construction is thought of by means of traditional elements. Some of the aspects causing these difficulties are: high number of elements, rectification and extension of a mapping, connections between different mappings [Nov84].

The design of hypermedia computer technology will help in the construction of CMs, once the above mentioned difficulties have been solved, and will also constitute a richer means for information representation and retrieval [Sch94].

2. HCM Development Methodology

Once the educational value of CMs and the significant contribution of hypermedia computer technology for their design are discovered, the following HCM development methodology is introduced.

Existing platforms for hypermedia developments have a great number of possibilities and options. The proposal of an HCM design using one of these resources in a completely free form, implies the high risk of not achieving the educational benefits mentioned by Novak.

For such reason, we have thought about a methodology that takes into account, in the first steps, the development of the CM as hypertext, leaving for final steps the different forms of representation of information and the corresponding choice of means.

Steps

I. Specification of the Concept to be Developed: the HCM shall be identified with the symbol representing the concept on which the mapping is developed. Thus, the word associated to the root node of the mapping gives the name to the whole HCM.

II. Assessment of Concepts Forming the Mapping: a list of ellipses will be made, each one with the word representing one of the concepts that will form the mapping.

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All ellipses shall be painted with the same color. Thus, an HCM will not only be identified with a name, but also with a color.

III. **Concept Classification**: the ellipses on the list shall be placed in different levels on the screen, according to a hierarchy by concept inclusion. Thus, the words representing more comprehensive concepts, shall be placed on the upper levels, and those identifying less general concepts shall be placed on the lower levels.

If the number of concepts determined at the step of specification is high in order to be displayed on a screen, the subset of more general concepts (of greater inclusion level) should be selected, leaving the rest for other HCMs that shall explode from the chosen concepts.

Definition: it is said that a concept C belonging to an HCM1 *explodes* in another HCM2 when said concept C is developed in the HCM2; i.e. C is the root node of the HCM2. In this case, it is said that the HCM2 is a hypermedia conceptual submapping (SubHCM) of the HCM1.

IV. **Establishing Relations between Concepts**: relations between concepts will be represented by arcs labeled with link words (one or more words symbolizing the relation).

i. Relations between Concepts of the Same HCM: labeled arcs will be plotted through a segment with the name of the relation associated to it.

ii. Relations between Concepts of Different HCMs: each of the HCMs involved will be added with:
   - a rectangular button labeled with the name of the concept that is in the other mapping. Such button shall be painted with the color of the HCM from which it comes.
   - a labeled arc with the corresponding relation joining the concept that belongs to the mapping and the other one added as a button.

Thus, it will be possible to visualize the relations between concepts located in different HCMs, and, moreover, one will be able to go to the other HCM using the button.

V. **Appearance of Concepts**: Once the basic scheme of an HCM and its relations with another HCM according to steps I to IV are defined, the extra appearance that one may want to choose for each concept will be determined. It is advisable that the extra appearance associated to a concept could be captured without losing sight of the word in the ellipsis symbolizing it.
Since in some cases it will not be possible to capture two or more appearances of concepts of an HCM at the same time (for example in the case of sound), it would be convenient to make the different appearances of the concepts of an HCM emerge one at a time.

VI. Enriching of the HCM: Hypermedia technology gives the possibility to enhance the power of a CM. Hypermedia based on the sources that gave place to said CM can be added to it. Access to it can be achieved during exploration of the mapping. HCMexploration then allows that those concepts, which due to their richness could give new information, be explored by means of hypermedia. Thus, two levels are created: a main level (the HCM itself) and a secondary level (additional information) that can be consulted alternatively.

With this enhancement, HCMs go beyond the educational possibilities of Novak’s traditional CMs. The mechanisms proposed give access to the sources of information which originated the design of the mapping. This hypermedia bibliography can be very useful for those interested in enlarging the subject, as well as for those assessing it.

3.3 Recommendations

- It is considered that an HCM should not have more than seven concepts. From a psychological point of view, this limitation is related to the maximum number of information blocks that can be withheld after a short perception span [Nov84]. From a practical point of view, it is attempted to get a panoramic view (in only one screen) of the most relevant concepts and their relations.

- When a concept X of an HCM M is developed into a subHCM X, and the addition of concepts of both mappings does not exceed the limits recommended for an HCM, it is advisable to join the HCM M and the SubHCM X in a single HCM.

5. Conclusions

The development of HCMs according to the methodology proposed will collect the benefits of motivation and information management of hypermedia technology, preserving, in turn, the pedagogical benefits of conceptual mappings.

Construction of an ad-hoc platform for HCM development is introduced as a very interesting option instead of the use of platforms for general hypermedia developments. The design of said specific platform points at the acquisition of those resources necessary for HCM development exclusively. Thus, possible spreading in aspects and implementation options, lacking importance from an strictly educational point of view, are avoided. The design of said platform is currently in process.

Bibliography