Mind-Mapping for Web Instruction and Learning

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Abstract

A common problem for faculty, when confronted with the task of enhancing class instruction or designing distance courses is how to convert fluid learning experiences to the Web environment. Based on experiences of faculty development at Franciscan University and Eastern Ohio Virtual School District, this study focuses on domain-specific instructional strategies and models called "learning templates" or predecessors of learning objects that can be applied to the curriculum at almost any educational level. They encapsulate web-enabled instructional events drawing from conceptual mapping, learning strategies and methods of inquiry. These templates and the learning objects created with them can be replicated, adjusted and reused.

Introduction

In a recent overview of instructional design for the new digital media, M. David Merrill declares that:

> Many of the current tools for developing technology-based training materials require considerable time to learn and even more time to use. Too often in the search for efficiency, there is a corresponding loss of instructional quality. A […] goal of instructional science is the search for tools that are significantly more efficient to use while at the same time promoting an improved quality in the product. [1]

Assuming this situation, this paper has the purpose of defining a more efficient method for transforming instructional events and strategies into Web-based learning objects. Educators, in any level of curriculum and discipline, can easily use it. This statement of purpose demands further clarification of the terms used. What kind of method is this? Why is to be used by educators? What is an instructional event? What is an instructional strategy? What is a learning object? How can one describe Web-based learning objects? The remainder of the introduction will be dedicated to provide a brief explanation of these terms to set the basis for further discussion.

The emergence of the Internet as the main international system for communications gave preeminence to the Web as platform for exchanging information in this gigantic "network of networks". The Web, in turn, is a combination of other modes of information developed by humankind in previous eras: Print, Imaging, Photography, Video, Mail, Teleconference, etc. The Web is also a tremendous vehicle for education and training; perhaps in larger measure than any other media in the past. The closest competitor might be printed text, but it is technically feasible to present anything printed in the Web. Educators have started building "virtual spaces" for Web-based learning, but the knowledge and skills needed to build those spaces are not quite widespread in the first decade of XXI Century. There is urgency for more efficient methods, as a *method* is essentially a combination of knowledge and skill to do something with less effort and waste. There are already certain methods in application for creating instruction in the Web, most of them requiring participation of professionals with multiple qualifications: subject matter experts, instructional designers, multimedia developers, etc. This leads to the question if there can be more accessible methods for educators and students without sacrificing quality of

instruction and learning. This paper is an attempt to respond to such question with a recently developed conceptual framework.

An *instructional event*, as defined by Gagne, [2] is an action during instruction that has some effect on learning. He prescribed nine events to assure successful learning when they are deliberately applied. These events include actions such as "gain attention", "recall previous knowledge", etc. In the context of this paper, the term "instructional event" is used in a more general way, meaning any type of action that facilitates learning. These actions can take place as actual teacher-student interactions or *virtual interactions* embedded in a given resource like an e-book or a set of web pages. The concept of instructional event has been broadly used and further evolved into the concept of *instructional strategy*, as used by Merrill [3] and others to identify a sequence of instructional events leading to achieve certain learning objectives. Merrill establishes that instructional strategies have at least two phases: presentation/demonstration, and application/practice. Furthermore, strategies can be broken down into "granular" events. The later are identified as: TELL (the student something), ASK (something from the student), (allow student to) SHOW (something), and (require the student to) DO (something). This possibility of decomposing instructional strategies into elements of lower "granularity" is a foundation for the type of method discussed in this paper. By examining the instructional events in a given instructional strategy, the developer can represent it by means of a radial diagram or map in which the nucleus corresponds to the topic or skill being taught, and the branches to the granular instructional events. Some examples of this process will be shown elsewhere in this paper.

Finally, *learning objects* are a recent development of instructional technology. The definition of the Metadata Working Group of the IEEE [4] is a good reference: "Any entity, digital or non-digital, which can be used, re-used or referenced during technology supported learning". To this definition, one must add that users of learning objects identify and describe them by means of *metadata*; which are sort of labels allowing electronic storage and manipulation of learning objects. They indicate properties of learning objects such as title, author, area of knowledge, learning objective, mode of presentation, etc. Metadata are coded on a commonly accepted protocol such as XML, and efforts are made to achieve standardized forms of coding. There are several groups working on this matter, SCORM, IMS, IEEE, Dublin Core and EML; all of them with presence in the Internet. The type of operations facilitated by metadata are searching, archiving, rearranging, copying and delivering objects in courseware. Due to all these features, learning objects present a potential solution to the methodological conundrum of generating reproducible instructional material, as capitalized by Wiley and contributors [5]. Furthermore, the pervasiveness of the Internet makes it possible to create learning objects anywhere and disseminate them worldwide to audiences in different contexts. It is foreseeable that independent learners, in near future, will search for the appropriate objects matching their needs; then, they will arrange these objects in appropriate sequences to achieve their desired goals with higher efficiency than they can do now through regular courses. This, for sure, will be accompaingned by tutoring services that already are available in the Internet.

The next sections of this paper will explain a method of object-oriented instructional design for the Web based on the concepts just exposed. First, there will be a brief explanation of the connection of this method with the theories of learning – to provide a general background. The second section is dedicated to analyze relationships between the cornerstones of this method; namely, learning objects (LO), learning strategies (LS) and learning templates (LT). The third

section describes steps of the method with examples. Finally, the conclusions examine strengths and weaknesses of this method and propose some ideas for further analysis.

Learning Theories and Web-Based Instruction

One question considered during the literature research for this paper was whether a method of designing Web programs could be derived directly from one or more learning theories. However, this effort proved futile. The theories of learning seem too divergent among themselves for several reasons: their creators came from different intellectual traditions, they focused on different aspects of the complete learning span of the individual from birth to death, and they used different learning tasks to validate their generalizations. Thus, each theory interprets learning phenomena in its own way, creating a Tower of Babel of terminologies, principles and applications. When one analyzes a comparative review of learning theories such as Reigeluth, Morris and Shermis, or Gredler [6] the first glance impression is that of the old Indian tale about the elephant and the blind men: each man gave a different version of the beast depending on the part touched with the hands. However, one must recognize that there is a unity in the object of study that has remained constant for thousands of years: the learning processes of the human being. They are the differentiating factor of the species and have no paragon in any other living creature. Therefore, a way to start integrating the learning theories is to look at the learning processes they have identified and try to derive applications of these processes to a specific area of instruction such as the Web. [7] Authors such as Greeno, Collins and Resnick, [8] and Koper [9] favor this integrative view that is also a starting point for this paper.

Table 1: Correspondence between Learning Theories and Learning Processes

Theories>	**Behaviorism**	**Cognitive**	**Constructivist**	**Socio-cultural**
Learning Processes	Watson, Guthrie Thorndike, Hull, Skinner	Koehler, Lewin, Tolman, Gagne, Miller, Ausubel	Dewey, Piaget, Bruner, Pappert, Fosnot, Wenger	Vigotsky, Merton, Miller & Dollar, Bandura
Psychomotor Skill	●●●	●●●	●●●	
Concept Learning		●●●	●●●	
Principle Learning		●●●	●●●	
Declarative Knowledge		●●●	●●●	
Problem-Solving	●●●	●●●	●●●	●●●
Procedural Learning	●●●	●●●		●●●
Cognitive Strategy		●●●	●●●	●●●
Attitude Change				●●●
Motivation/Interest Change	●●●		●●●	●●●

To begin with, nine general learning processes will be considered according to the typology summarized by Smith and Ragan: [10] Psychomotor Skill, Concept, Principle, Declarative Knowledge, Problem-Solving, Procedure, Cognitive Strategy, Attitude Change, and Motivation/Interest Change. This typology corresponds to an eclectic view of learning processes with intertwined contributions of the main streams of learning theories: Behaviorist, Cognitive, Constructivist and Socio-historic. Table 1 indicates some foremost authors in each of these streams and the areas of contribution. For each one of the learning types, it is necessary to identify appropriate learning strategies and build templates representing embedded learning events; this task is left for future work, but some of them will be exemplified here.

Components of Object-Oriented Model of Design

The primary components of the instructional design method here described are *learning objects, learning strategies* and *learning templates*. Fig. 1 delineates the relationships among these components, briefly explained as follows. Learning objects are granular components of instruction that allow achieving predefined learning objectives. A course can be seen as a collection of learning objects that involves acquisition of a broader range of knowledge and skills. However, the term "collection" can be misleading. The learning objects in a course are not grouped in an additive manner, like beads of a collar, but they follow higher order strategies and sequence rules belonging to the course as a whole. On the other hand, there are components of the course that cannot be assigned to individual objects; for instance: presentation of author(s), rationale, intermediate and final assignments, annotated bibliography, etc. In a sense, the course is a super-object that involves smaller learning objects. One of the great advantages of this method is that these smaller learning objects are not restricted to a specific course, and different instructors can use them in other courses with different purposes and even with variations in content components and mode of presentation. Furthermore, individual learners can retrieve these learning objects and use them independently.

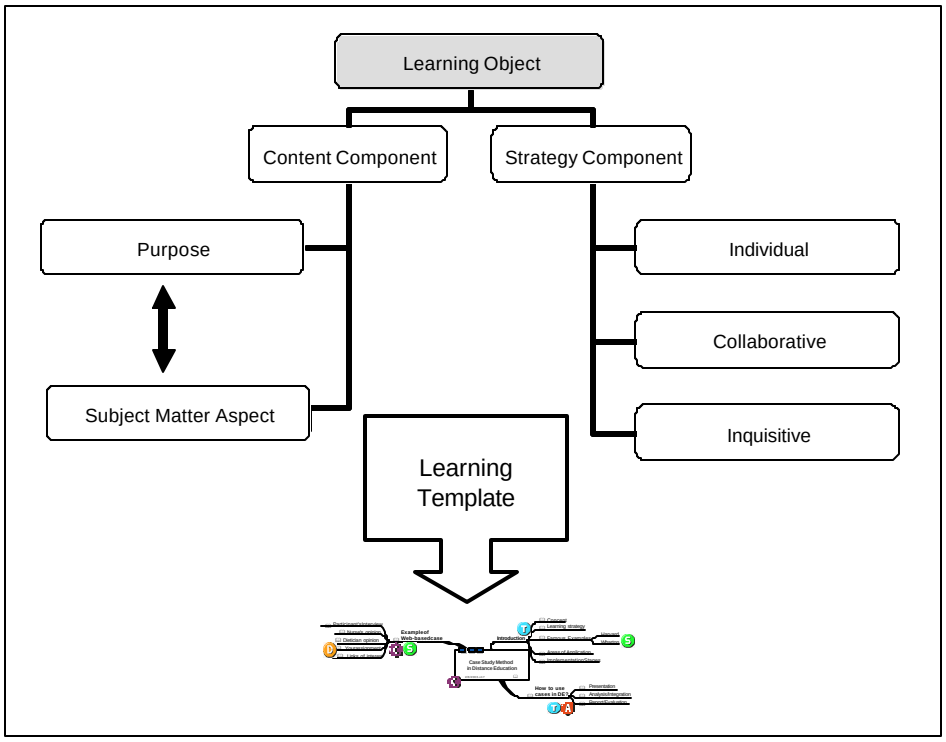

Fig. 1: Conceptual Components of Object Design Method

How to construct learning objects? Merrill establishes that "Instructional design requires two major activities: Determine what to teach? Determine how to teach?" [11] Then, a learning object is a combination of two "primitive" elements: a *content component* and a *strategy component*. The content component corresponds to a topic, a skill, a fact, or collection of facts, etc. It responds to the question 'What?' However, it answers not only to this question because an instructional content is related also to a certain *purpose*, a 'Why?' For instance, one does not teach "Cell Structure" in abstract. This topic has different purposes and granularity whether it is

presented to Eighth Grade students or to First Year college students of Pre-Med. This means that an important component of content is the expected *learning objective or objectives* that the student will accomplish in interaction with this content. The *strategy* component corresponds to the 'How?' question, or better: How the learner interacts with content? The learning strategies are quite diverse but they can be grouped into three broad categories: *individual, collaborative* and *inquisitive.* Table 2 summarizes the definitions of these types showing examples from the literature on teaching and learning.

Table 2: Typology of Learning Strategies

Individual Strategies	Collaborative Strategies	Inquisitive Strategies
Definition: The learner achieves the desired knowledge, skill or attitude change by interacting with content on a one-to-one relationship, either directly with materials or through mediation of a more expert person (teacher, mentor).	**Definition**: The learner achieves the desired knowledge, skill or attitude change by interacting with peers or experts in a collaborative way; the final outcomes depend on the contributions of participants in the process –including the learner.	**Definition:** There is no pre-defined knowledge, skill or attitude change, but rather learning is based on searching for these elements under broadly defined criteria or questions. Each learner obtains something different.
Common examples:	**Common examples:**	**Common examples:**
Lecture	Dialogue	Discovery Learning
Drill and Practice	Guided Discussion	Experiential Learning
Storytelling	Case Study	Topic Search
Tutorial	Project	Seminar
Demonstration	Workshop	Field Observation
Virtual Tour	Gaming	Brainstorming
Problem Solving	Problem-Based Learning	Role Playing
Mastery Learning	Action Learning	Portfolio Learning

The above discussion leads to general orientations for preparing learning objects. First, the developer identifies the content that can be loosely or precisely defined. Second, he or she must find an appropriate learning strategy to involve the students in interaction with this content. This is not a question of finding "the right match" or even "a good match", because learning is a very idiosyncratic phenomenon; every person learns in a unique way which changes along the lifespan. However, the instructor can appeal to successful teaching practices in the past, peer advice, best practices collected in Internet repositories of lesson plans and other sources.

Learning strategies, as listed above, are combinations of Merrill's granular actions [12] – i.e. TELL, SHOW, ASK and DO. These actions can be organized around a *radial* structure as in a conceptual map. In other words, there is a *core* concept, idea, skill or attitude at the center of the diagram and related elements around this core, which will be called *branches*. The relationships between core and branches may have different meanings: some times the branches are derivations from the core; some others are steps of a process indicated in the core, or questions related to an issue, etc. For example, the image in Fig. 2 contains a map for the topic "The case Study Method in Distance Education"; which was used for a course unit about diet plans for pregnancy. As seen, the core topic has three branches: "Introduction", "How to use cases in Distance Education", and "Example of Web-Based Case". The learning processes involved are concept learning and procedural learning; on the other hand, the dominant learning strategy is *demonstration*: the instructor announces a topic, explains it, and shows an example. The whole graphic can be defined as a *learning template* because this basic structure can be used for many other topics involving demonstrations. The template is like a container that teachers and/or

students can fill with information relevant to the course being taught. This information can be in any format – text, image, audio, video, Internet links, etc. It must be adapted also to pedagogical rules that increase the likelihood of learning. [13] When a given user "fills" a template, he or she can add or delete branches, add or delete connecting relationships, use a different approach of language depending on the audience, use different layout of Web pages, etc. Finally, with the aid of a computer application, the user will be able to generate a set of inter-connected Web pages that contain the learning object. These pages must be compliant with an interoperability protocol that has been chosen for displaying Web content, usually XML, and they must have affixed metadata to facilitate archiving and retrieving this learning object from databases. The application used in this example is *MindManager*™; a product of Mindjet Corporation extensively used in Franciscan University of Steubenville for creation of learning objects.

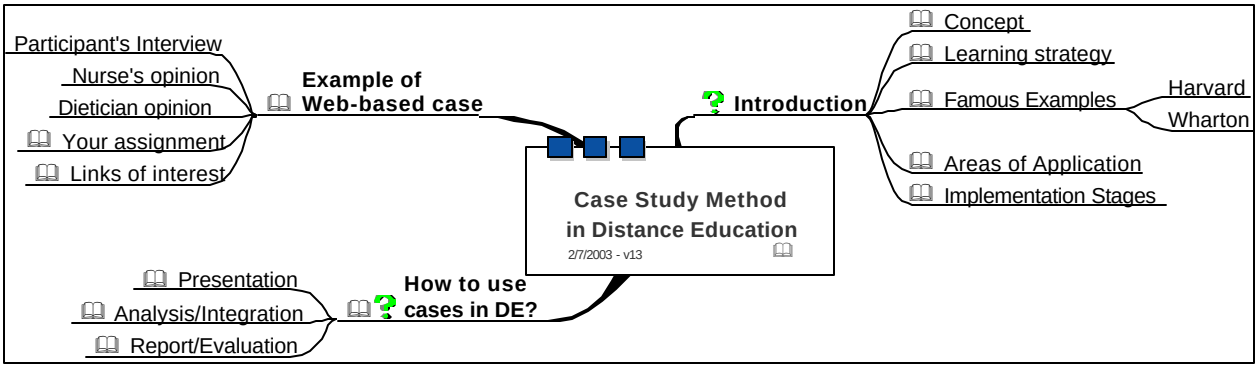

Fig. 2: Example of Learning Template (Map)

From Mind-Map to Web: The Method

This section is dedicated to describe the steps of the object-oriented instructional design method for the Web. The author validated these steps through many faculty development programs. [14] However, it cannot be considered a ultimate guide for elaboration of this kind of instruction. It is necessary to submit it to new validation and case studies until it reaches high reliability of results.

Step 1: Schematic design of the course or unit

Before thinking in learning objects, it is convenient to have a global idea of the course. This can be achieved by elaborating a matching table of components for each unit. This table includes objectives, content, resources and interaction; as indicated in the example below.

Table 3: Example of Unit Outline

Objectives	Content	Resources	Interaction Strategy
To determine how the processes of production of a company influence the design of its structure.	-Premises of organization design. -The company's workflow. -Workers' distribution according to tasks.	- Text for the unit. - Application for organizational charts. - Cases of organizations A, B, C.	- Read design principles and answer short questions. - Review cases on the screen. - Use OrgChart application to design appropriate structures.

This type of outline helps the developers to maintain coherence between the user learning purposes, the content presentation or discussion, the kind of multimedia resources, and the way the user will interact with the program (strategy).

Step 2: Conceptual map of learning object

A conceptual map, as used in the context of this paper, is a graphic representation of a multimedia lesson or series of lessons. Instructors and students can elaborate this map manually or with the aid of software. The latter is preferred, because it facilitates collaboration during the process and makes it easier rendering the Web pages. The map in Fig. 3 represents the knowledge and skills that the user will grasp as he or she learns. This map is more complete than the one in Fig. 2 in the following: (1) the learning events are coded according to the convention suggested by Merrill [15]: T=TELL A=ASK, S=SHOW, D=DO; (2) A C=CHOOSE event has been added to represent the frequent action of selecting from a menu or list; (3) more DO events have been added to increase active learning. Another convention in this map is that all branches with content show a little 'book' icon, while the empty branches show no icon. It is essential that the developer carefully analyzes how to display in this way each course unit. The list of strategies in Table 2 can be helpful to select the appropriate one according to the content component (which includes the purpose). Then, the developer can experiment with different templates that are able to reproduce such strategy; there is a 'basic' template for each strategy and many variations. [16].

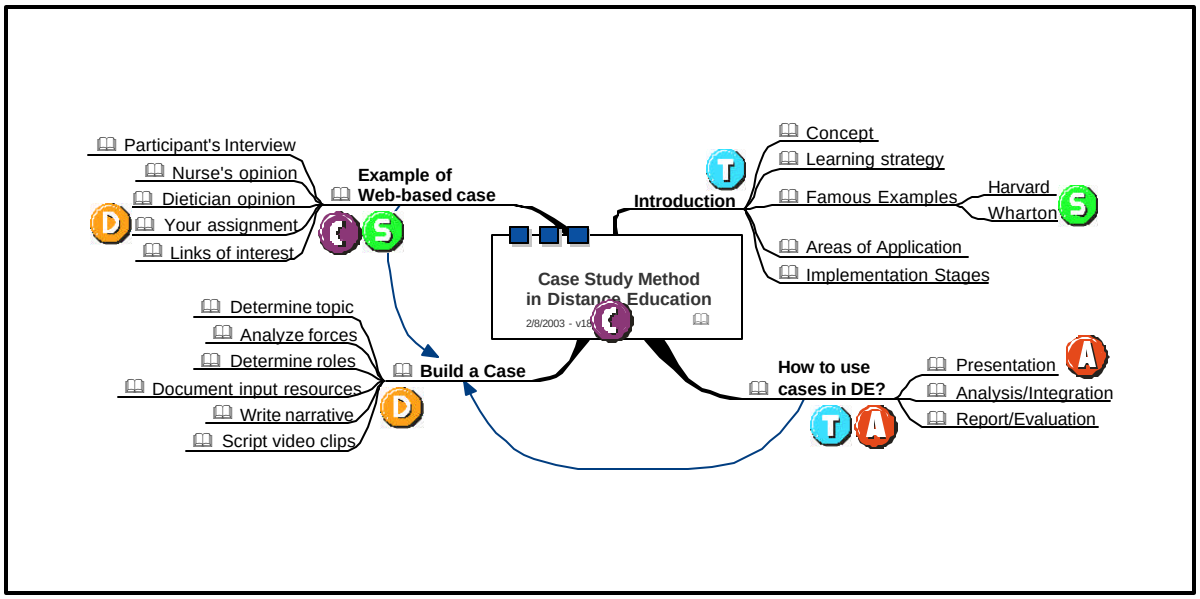

Fig. 3: Example of Finished Conceptual Map

Step 3: Write a detailed script of motion media

Quite often, learning objects include motion materials such as audio recordings, animations or videos. If they are not previously available, it is necessary to produce them with appropriate tools and finally insert them into the corresponding Web pages. This process demands time and resources. If it is not carefully planned, it may originate considerable waste. Therefore, it is convenient for developer to elaborate scripts of these materials to be used by media producers. A

script is a narrative and sometimes-graphic outline of a motion media resource. There are different ways of composing scripts:

a) A two-column manuscript with audio column, on one side, and indications for video or animation, on the other.

b) As a storyboard, in which the audio and video are represented through graphic sketches giving a more precise idea of the shots.

c) As a three-columns script, with specifications of content, multimedia elements and student's actions. This is the one recommended because it is more thorough.

An example of it is as follows:

Table 4: Excerpt of Motion Media Script

Scene	Content	Multimedia Elements	Activities of the Student
1	Definition of Organizational Structure and of the three basic approaches to design: workflow, clustering employees' according to roles, and reporting system.	**Medium shot** of professor describing organization design. **Animated image** of organization chart. The org. chart takes different forms according to the design approach. Explanation appears in animated balloons. Menu to choose the approach that the user wants to explore.	Click on design approaches to see differences. Explore explanations of each approach in hypertext.

As observed in the example, each one of the multimedia components (highlighted in bold) requires a special production effort. One key function of the script is precisely to identify those elements that have to be produced or can be borrowed from somewhere else. When the developer presents a script like this, it is possible to derive a list of work orders for text, animation, video and so forth.

Step 4: Compose Web Pages with the Authoring Tool

The user fills the map branches and sub-branches with information and they are automatically converted to Web pages. Each branch must contain meaningful information by itself, because the user will see it separetely. Typical content of Web pages are: explanations, procedural guides, comparisons, demonstrations, and lists of questions… the possibilities are almost infinite. Some common rules for good Web communication are applicable:

- Be brief in the presentation of content; a screen is not a textbook page in which one can include a lot of verbal information.
- If the author thinks that the student must read a certain article or chapter of a text – then include it as an attached file rather than part of the body of the Web page.
- Look for additional resources that can be found in the Internet or in special databases, and point to them from links in the branches.
- Images, animations or videos are good substitutes or complements for words when certain ideas are not easy to verbalize. Human voice in audio files adds a motivational aspect to words.

- Do not overload the user with many links; make an estimate of the time required to go trhrough the lesson.
- Facilitate dialogue and discussion whenever convenient; for this purpose, the page can offer space for response with a 'Submit' button.
- Include open questions at certain points of the lesson and link to e-mail address for sending comments.
- Try to use assessment activities every time that the user has completed a significant part of the lesson.
- Assessment questions can be introduced as true/false or selection items, with immediate feedback. This is one aspect that keeps users interested during the whole lesson.

Fig. 4: Excerpts of a Rendered Web-Lesson

Step 5: Render the Learning Object in the Web

The *MindManager*™ tool allows directly exporting the map as a set of linked Web pages in just a few seconds or minutes. However, it is convenient to define certain parameters of design before exporting, such as: font sizes, background color, use or not lateral frames, level of detail of branches, etc. All these aspects are controlled by commands of the program that the user can easily locate with the program tutorials. Fig. 4 includes four typical pages of a lesson generated with this program. The first one, from left to right, is the Home Page where the lesson starts; it contains a brief introduction and a menu to access the different parts of the lesson. The second is a sub-menu for a topic. The third is the introduction to a case where an image is used for realism. The fourth includes a video with an interview of a person involved in the case –not shown here. The whole lesson can be taken in about 15 minutes.

Step 6: Evaluate and Make Adjustments

The first attempt to generate a Web lesson with an authoring tool such as the one discussed in this paper is rarely completely successful. The developer has to review all pages and test them for clarity, coherence, language, quality of multimedia resources, and so forth. It is convenient to take notes of required changes, go back to the map, do these changes, and render the lesson again. After a few trials, a good result can be achieved. "Practice makes perfect" seems to be underlying motto of Web-based learning design.

Conclusions

The method that has been presented through this paper is a product of gradual improvements over a basic idea. It has been used many times in workshops with Higher Education and High School faculty, and the results are positive in general. After a few sessions, participating preofessors and teachers have been able to produce utilizable Web-based lessons. Perhaps the key to this poitive impact is that, during the whole process, they work more on instructional concepts and principles than on programming techniques. The environment is relatively free of commands and lines of code. Other important features are that participants work with topics they know well, they collaborate in the analysis of content, they generate their own maps and criticize them, and they start exporting maps into Web lessons since the initial stages of training.

It follows a list of recommendations that can remediate some current limitations of the method:

- It is necessary to build a number of learning templates for each one of the main instructional strategies. These templates must be adapted to the content of different disciplines becasuse there are deep differences in pedagogical approaches among the disciplines.
- For the same reason, it is convenient to build a number of exemplary learning objects in different disciplines that can be used as reference by developers.
- Special guidelines are required for collaborative and inquisitive learning objects, in which students have participation almost at the same level of the instructor in the creation process. They represent a challenge because not all their components can be planned in advance.
- It is convenient to train also the students in learning object development, because these skills can be used to improve their academic work in general. It is convenient to evaluate to what extent the involvement of students in content mapping has an impact on achievement.

References

[1] Merrill, M. D. (2003). Components of instruction: toward a theoretical tool for instructional design. *Instructional Science* (In Press). London: Kuwler Academic Publishers. Pp. 6.

[2] Gagne, R. M., (1965). *The Conditions of Learning*. Holt, Rinehart and Winston, Inc., New York. In this classic book, the author uses for the firsts time the famous term "learning event". Then, he reinstates it more formally in: Gagne, R. M., (1992). *Principles of Instructional Design*. Holt, Rinehart and Winston, Inc., New York.

[3] Merrill, M. D. (1999). Instructional Transaction Theory (ITT): Instructional design based on knowledge objects. In C. M. Reigeluth (Ed.) *Instructional Design theories and models: A new paradigm of instructional theory*. Hillsdale, NJ: Lawrence Erlbaum Associates.

[4] IEEE (2002) *Institute of Electrical and Electronics Engineers*. Web page on Learning Technology Standards Committee: http://ltsc.ieee.org/

[5] Wiley, David A. (Ed.) (2002). *The Instructional Use of Learning Objects.* Washington: Agency for Instructional Technology (AIT) and Association for Educational Communications and Technology (AECT). This work is preceded by: Wiley, David A. (2000) Learning Object Design and Sequencing Theory. Doctoral Dissertation. Provo, UT: *Brigham Young University* (Department of Instructional Psychology and Technology).

[6] These are popular books about theories of learning that emphasize the applied aspects:

a. Reigeluth, Charles M. (Ed.) (1987) *Instructional Theories in Action*. Hillsdale, NJ: Lawrence Erlbaum Associates.

b. Bigge, Morris L. and Shermis, S. Samuel (1998) *Learning Theories for Teachers*. Sixth Edition. New York: Longman.

c. Gredler, Margaret E. (2001). *Learning and Instruction: Theory Into Practice*. Columbus: Merrill-Prentice Hall.

[7] The author discusses in more detail the theories of learning and possibilities of integration in: Chacon, Fabio (2001). Restructuring Practice and Research on Instructional Technology: An Urgent Need. (Unpublished) Intervention in International Panel on the Status of Instructional Technology; Department of Instructional Technology and Distance Education. Fort Lauderdale, FL: *Nova Southeastern University.*

[8] Greeno, J.G., Collins, A. og Resnick, L.B. (1996): *Cognition and Learning*. I Berlinger, D. og Calfee, R. (red.): Handbook of Educational Psychology (s. 15– 46). London. Prentice Hall International.

[9] Koper, Rob (2001) Modeling units of study from a pedagogical perspective: the pedagogical meta-model behind EML. *Open University of the Netherlands*. Internet publication: http://eml.ou.nl/introduction/docs/ped-metamodel.pdf

[10] Smith, Patricia L. and Ragan, Tillman J. (1999) *Instructional Design*. Second Edition. New York: Wiley.

[11] Merrill (2003), *Op. Cit*. p. 6.

[12] Merrill (2003), *Op. Cit*. p. 13.

[13] A discussion of the pedagogical rules for displaying information in Web pages, combining multimedia elements, is out of scope with the central purpose of this paper. An excellent summary about these rules can be found in: Clark, Ruth C. and Mayer, Richard E. (2003) *e-Learning and the Science of Instruction.* San Francisco: Jossey-Bass/Pfeiffer. See also: Bannan-Ritland, Brenda; Dabbagh, Nada; and Murphy, Kate (2002) Learning object systems as constructivist environments: related assumptions, theories and applications. In David A. Wiley (Ed.) *The Instructional Use of Learning Objects.* Bloomington, IN: AIT/AECT.

[14] The author has taught faculty development courses and workshops with this approach in higher education institutions of Latin America and United States: Universidad Central de Venezuela, Universidad de Carabobo (Valencia, Venezuela), Nova Southeastern University (Fort Lauderdale, FL), and Franciscan University of Steubenville.

[15] Merrill (2003), *Op. Cit*., p 10.

[16] The author of this paper is currently working on a project for developing a Learning Object Generator tool. This involves constructing dozens of "primitive" learning templates and hundreds of variations. This is work in process, therefore the results cannot be reported here.