# The Need of Structured Methodologies in New Learning Strategies

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## ABSTRACT

All universities and training institutions are making significant efforts to make courses and teaching materials available on the Internet. Although the WEB provides a rich set of tools to support this process, to achieve learning efficiency is not trivial. This paper proposes a systematic approach for creating WEB based courses, which integrates learning objectives, pedagogical activities and technology. It also identifies the main decision making points about design and author for Internet delivery.

**Keywords:** Web-based learning, Education, Learning technologies.

## 1. INTRODUCTION

As universities and training organizations move increasingly into offering telematics based education and training, the development process of Internet courses is evolving from the status of handicraft activity to that of an industrial process. As a consequence, the development process must be modelled so that each activity can be supported both at conceptual and technical level. This will ensure the existence of quality and relevance in the final product and lead to cost effectiveness in the production process. Research on better models, methods and tools is bound to have a crucial impact on tomorrow's authoring systems.

The INTELLECT[1] project aims to develop innovative Internet based courseware targeted at a distance learning audience. Specifically, the project looks at different ways, to explore the use of new technology and media as education delivery devices to a diverse, multi-cultural, population of students. The project thus aims:

- to develop an understanding of design and structuring principles for WWW based education documents for distance learning.
- to explore the type and nature of educational experiences afforded by the use of new evolving technologies (e.g. multi-media, VRML and Hot Java), together with the non-trivial consequences of their integration.
- to develop intelligent coaching agents able to give students learning support for specific topics.

The Internet will be used as a backbone for the administration and delivery of flexible, multi-media courseware. However of principle interest is an understanding of the mapping between curricula content and appropriate delivery media. Through a series of experiments and evolving prototypes the project aims to deliver an evolving methodological handbook about how to design and author for Internet delivery. A principled focus of this project is how to manage the process of design and delivery. By starting from a detailed conceptual model of precisely what we are trying to teach the project is systematically exploring how different delivery techniques and technologies affect (i) learning performance, (ii) the students' quality of experience, (iii) usability, (iv) technical pragmatics outside an academic project, and (v) cost.

In developing any kind of hypertext material, developers face decisions, related to hypertext design issues. Each of

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the design decisions has a specific impact on the final product. Having a predetermined goal in mind (to address a certain audience), the decisions to be made must produce effects consistent with these goals.

The design principles we present here are born out of our desire to document what the design decisions were, and how or why we made them. The list is by no means comprehensive. The dynamic nature of the World Wide Web necessitates that any resource like this, be dynamic, changing and never "complete". We are learning, about these principles. It is our hope that the report of our design experience may serve as a practical introduction and a basic guide to good web page design strategies.

## 2. A PROPOSED STRUCTURE FOR WEB BASED COURSES

There are many approaches, one could follow in converting teaching materials from existing text form into hypertext. In most cases developers follow an ad-hoc approach. Here we present a structured approach born from our experience in the INTELLECT project. This structure approach is based on the following principle:

Learning Material can be analysed and identified by 3 factors:

i. The learning space, as this is identified by the course's learning units,
ii. The pedagogical activities necessary to support the learning process, and finally
iii. The appropriate technology to be utilised at each pedagogical activity.

A proposed development action plan, therefore, must be defined on a three dimensional space, defined by the following axes (Figure 1):

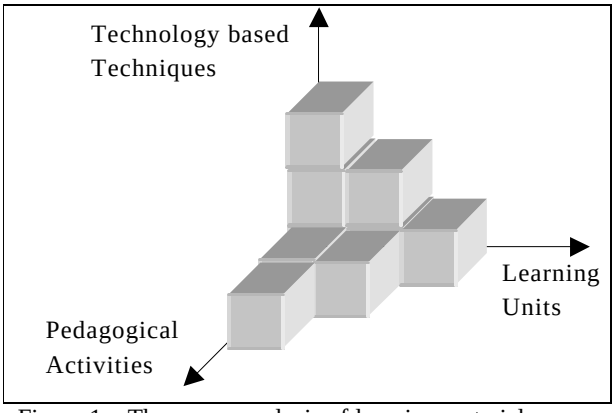


Figure 1 – Three way analysis of learning material

***Learning Units***

Learning Units can be identified on the basis of the existing educational material and should correspond to sections and subsections which serve a specific learning objective. To convey the knowledge of each learning unit, a set of appropriate pedagogical activities must be defined, and appropriate techniques must be utilised. Not all combinations of pedagogical activities and hypertext techniques are technically feasible or educationally fitted for each learning unit. A selection process must identify, which blocks of the grid in Figure 1 will be filled, in order to arrive at a value-added hypertext version of the original material.

***Pedagogical activities***

Hypertext structures can enhance the value of educational material by providing in addition to knowledge, an interactive mechanism between the student and the educational material, which can support different pedagogical activities, which we believe that lead to enhancing knowledge.

Hypertext educational material can thus be organised along various pedagogical activities, which may include:

1. Presentation of Knowledge
   This can be done by providing:
   a. Definitions of Concepts.
   b. Textual and Graphical / Pictorial Descriptions on specific educational elements.
   c. References to other sources of educational information, especially in the form of direct links.
2. Examples
   Examples illustrate in various forms (text, graphics, animation, video etc.) the educational information, which was initially provided in conceptual form and could be:
   a. Concept examples, usually of short length
   b. Case studies, which are longer and assist in a better comprehension and integration of knowledge.
3. Exercises
   Exercises help the student to apply the knowledge acquired through the previous elements (1 and 2). Exercises could provide links to specific learning items contained in (1) and (2), thus reinforcing learning and enhancing the learning process. Exercises can be provided in different forms such as:
   a. Multiple choice
   b. Free form question / answer
   c. Practice exercises aiming in applying certain methodologies and procedures
   d. Filling the Gap
   e. Group Exercises
   f. Self - Tests
   Interactive hypertext provides an appropriate media for developing self - tests as elements of the learning process. Self - tests have the same structure as exercises but the aim is obvious different. No interaction with learning items (1) and (2) is provided. Instead, the features of the interaction mode between the learner and the system must include time limits on completing a test, grading mechanisms and appropriate feedback to the learner.
4. Communication
   Today's hypertext environments implemented on the WEB provide the means for easy communication between the main actors in the learning process: teachers and students. Communication elements could include:
   a. Bulletin boards containing announcements regarding the module
   b. E-mail facilities between tutors and students

c. Establishment of chat rooms and discussion groups for reviewing various issues and providing communications between students.

***Techniques***

Examples of hypertext techniques include animation, exploring hypertext links, video etc. It is obvious that not all techniques are efficient for each pedagogical activity; some could even be totally inappropriate. For example an animation technique could be used to demonstrate the searching mechanism in a database and to provide the means of simulation of data retrieval.

For the purpose of INTELLECT the following techniques could be explored in order to examine the appropriateness of each technique for specific pedagogical activities of each learning unit:

- Hypertext Links (internal and external): For long term knowledge transfer a relational structure can create an interactive environment that permits "repurposing" of existing materials, and offer directions to activities appropriate for the learner's task and level of expertise. A hierarchical structure can be used on the other hand for searching browsing and information retrieval
- Use of Metaphors to create a more accessible interface
- Navigation techniques include access to facilities, such as maps, an index of keywords, a guided tour etc.
- Mapping techniques can include site maps to visualise the document structure and reduce disorientation, and reorientation tools for nor "being lost in hyperspace"
- Easy communication w/ tutor or fellow students
- Simulation and Animation
- Video

## 3. CLASSIFICATION OF HYPERTEXT DESIGN DECISIONS

In most cases the process of creating a WEB based course is based on converting and integrating existing educational materials in other forms, usually text but also in forms of computer based exercises, games, reference materials etc. To meet the above objectives certain design decisions must be made along the way in order to have the desire positive effects of a rich hypertext environment. Hypertext Design Decision can be classified in five groups as follows:

***i. Hypertext Technology.***

These decisions concern the selection of the right platform for developing and delivering the course. The technological environment is changing dynamically and is very difficult if not impossible to follow certain standards. However developers must ensure a sound technology background whish is available to all users of the materials and supports all features of the course.

Hypertext and multimedia based learning material can be developed on different platforms. One choice could be to select a commercial authoring system for development and deployment of the material. Although this choice gives the developer more flexibility and control over the design and richness of the underlying structure it has an obvious drawback: it requires the user to have compatible software installed for viewing the material. A second choice is to select the World Wide WEB as the delivery media which allow any potential user to have access to the learning material. However this choice introduces certain limitations with regard to the hypertext structure of the course. Any Web application displayed inside a browser, it inherits many of its style features from the browser itself. This will impose certain limitation on its hypertext design, which must be taken into consideration in the mapping of the course content to a hypertext structure.

Some of the desired outcomes can be implemented only if a certain technology is used. Technology selection is also related to personnel experience and knowledge. People tend to use what they know better. Decisions on technology are usually left to a large extent to the development team.

***ii. Material Content.***

The main rational in converting teaching material to hypertext format is to provide a much richer environment for the learner in order to facilitate flexible and individual learning. Therefore existing material in text form, must be enhanced both in terms of content and in terms of learning activities that can be supported. Decisions must be made in order to:

√ Provision of other on-line resources that can be in the form of URL references containing relevant information.

√ Pages with "assimilation test" which provide the means for student self-assessment and evaluation of the learning process.

√ Interaction activities through the net such as communication with the tutors or classmates.

√ Practice sessions.

***iii. Material Organization.***

Most of the times WEB courseware materials exist in another form, mainly text. Text materials organized in a linear fashion have structural elements such as titles sub-titles, chapters, sections, paragraphs, sentences, words, figures, tables and indexes. Nodes of a hypertext structure must recognize these structural elements and links can be constructed as appropriate.

Organization of teaching materials in the WEB is not trivial. A series of decisions must be made on how to structure existing linear material along WEB pages. Flipping pages in a book and flipping pages on the web are dramatically different. A student reading a book has random access to any page. They can flip one page, two pages, skip a whole chapter or jump to anywhere in the book randomly. In hypertext, the user is limited to accessing pages through hyperlinks that have been provided by the designer. The access of pages is not random and is determined by the designer. As a result, control shifts toward the designer, away from the user. The designer must have a reasonable idea of how users will intend to use the web pages and anticipate their needs, providing a linking strategy, which affords efficient navigation and accessibility.

Furthermore, in hypertext, the transition from page to page takes much more time than flipping pages in a book,

which is done instantly. The reader of a book can have fan flipping through dozens of pages at a time, instantly scanning for relevant information. But because of the slow loading times, a hypertext user cannot 'skim' pages. A user must follow a link and spend valuable time waiting for the browser to process the URL and download all the files (including graphics), sometimes only to find that the information contained therein is irrelevant.

***iv. Presentation of Material.***

The flexibility of hypertext and its powerful way of presenting materials does not come without a cost. Careful decisions must be made about the way materials are presented to the learner including the proper design of linkage and navigation techniques, user control, design of WEB pages etc.

A good designer will strive to minimize the user's confusion by developing an organizational structure, which allows him/her to develop a useful 'mental model' of the web site.

A mental model is a conceptual picture or map of how the pages on a web site are organized. It allows a user to maintain an idea of where in the hierarchy of pages they currently reside, and how to navigate to the information they are looking for. The goal is to provide only enough linkage for the user to accomplish his or her tasks in the most self-evident and visible way possible.

What is enough linkage and what is too much? Connectivity, or cross-links, among pages in a web site is great. Unfortunately, the sacrifice is that the mental model becomes more complicated as the user tries to register how the pages are linked in his/her head. The notion of the designer anticipating user tasks (as applied in user interface design) should be applied in web site development. Ultimately, it is the designer's responsibility to determine what is enough and what is too much. The amount of linkage is directly proportional to the resulting mental model. Straightforward linkage makes for a simple mental model. As the amount of linkage increases, so does the complexity of the user's mental model. The benefit of more links is more efficient navigation of the web pages, as the user can jump from page to page more easily. Although there are no steadfast rules, there are scenarios where one mental model over another is more appropriate.

Consistency and predictability contribute to a good mental model. A good design is a predictable design. Users quickly adjust to the 'look and feel' of WEB pages, so pages must be kept consistent. Users (rightfully) expect that pages should follow similar formats. Unnecessarily changing page layout confuses the users.

***v. Management***

Finally, given the dynamic nature of a WEB base course, proper management decisions will ensure

- Human resources selection. The availability of the right caliber personnel is of outmost importance for the development of advanced hypertext versions. Personnel availability is limited in those areas of advanced technology with increased market demand (like Internet development).
- Cost effectiveness, so that the development cost of hypertext materials will justify the value added to the learning process.
- The continuing update and enhancement of the teaching material, and
- The incorporation of any new technological advancement in the design of the WEB pages as new technology becomes available.

## 4. CASE STUDY RESULTS - EVALUATION

The above design principles and considerations were applied in converting the existing teaching material of a Database course in a hypertext form. In order to evaluate the effectiveness of the initial decisions made in the conversion of the INTELLECT Database Course from the conventional text form into the first hypertext version an expert opinion survey was conducted by the design team. The evaluation was made using a small group of opinion experts, which consisted of four lecturers at the Technological Education Institute of Larissa, all of them with IT background, who have taught database courses before. It must be noted that one staff members who was also asked to participate in the study, refused, reporting that they feel that learning materials of this form provide very little or zero value added to the learning process. The expert group was given a small introduction about the purpose of the intellect project and the goal of this study, and was asked to regard the hypertext prototype of intellect as a potential learning tool, which they could be offered to use voluntarily in their teaching. To facilitate and structure their responses the questionnaire described in the following section was given to each one of them, but they were also instructed that they could report on any item they think it is important but not contained in the list of questions. They were asked to return their opinions within a 20-day period. A summary of the most important research findings follows.

1. *Do you feel more comfortable to explore learning material in general "turning up the pages' of a "textbook" or you find more natural a navigation provided by a hypertext structure.*

   The prevailing answer is that they use both. Regardless of the existence of hypertext material most tutors like to also use course material organized in a linear textbook like structure.

   Even in the absence of a conventional book, the material in hypertext form must be organized in such a way that in parallel with the hypertext structure, one can also find a linear path through the material.

   They also reported that any hypertext material designed to be used as a main or supplementary teaching aid it is necessary to have an easily accessible index.

2. *Have you used any hypertext structured material before as a student / trainee, or tutor, or just out of curiosity?*

   All of the tutors are familiar with the use of hypertext and multimedia material in learning, but they have only used specific material out of their own interesting

in order to personally evaluate the technology. No use of hypertext material in any form in the teaching process was reported.

3. *Does the navigation of the INTELLECT course provide free and natural movement within its content?*
   In general the overall opinion is that the navigation design in this pilot hypertext design is adequate allowing the student to identify points of interest with no difficulty and to move easily and freely to any place in the course. It is positive that the material is organized in units and in activities within each unit. Regardless of the hypertext structure, the student should not have problems identifying study materials. Some of the individual remarks:
   - ✓ The frame-based design allows easy access to specific activities in each unit of material.
   - ✓ A very helpful item in the design is the unit summary, which give the students an overall idea about the specific contents.
   - ✓ Navigation instructions are necessary for the novice student.
4. *Do you, at certain points, get lost when navigating the course? Please identify these points and give a short description of the problem.*
   No major difficulties were reported. The overall opinion is that students should not have serious problems although some minor enhancements changes could help the overall performance. These could include:
   - ✓ Students may not so easily understand the natural «page-flip» navigation initially. Any difficulty of this sort may result in a loss of momentum in students and discourage them to "stay" with the course.
   - ✓ The "First Page" button creates confusion because it links to the beginning of the module and not to the first page of the unit as it is naturally expected.
5. *Does the structuring of the module's learning material help your students better understand (perceive) the subject matter?*
   Tutor's opinions are divided. Half believe that the material is well organized and it will help students to absorb and comprehend the subject much better. The course can be used as an alternative to books and book tutorials on the subject.
   However there is an opposite view stating that the novice student will very fast get tired, basically because hypertext navigation is not something students are using a lot and are familiar with.
   The main suggestion is that to keep student's interest high on the learning materials the hypertext course must provide:
   - ✓ More external links so the students can get identify immediately a value added feature of the course, which save him / her time.
   - ✓ More integrated application examples, especially not textbook made examples but more real-world like. This could be another value added feature, which no book can offer.
6. *If you use INTELLECT in teaching a course, do you feel that your students will be active participants in the learning process?*
   There is a consensus of opinions that using INTELLECT like materials as a supplement learning material, which students must have easy access to during their study time can increase active participation of students in the learning process.
   One important issue, which was raised, is that the provision of student – tutor interaction is very significant and if a feature like this is more well designed, allowing, "chat – type discussions", this could create a more attractive learning environment.
7. *Do you feel that the means for communication, with your tutor and your classmates, that the course provides are sufficient?*
   The tutors feel that although the e-mail provision gives students the opportunity to communicate with the tutor, major enhancements are required. These are two folds:
   i. Provide a more interactive way of communicating (as reported in question 6).
   ii. Provide action-based interaction as in the case of assignments and exercised.

   The last suggestion is something that must be considered in the design of intelligent agents, which can substitute some of the interaction between students and tutors.
8. *Do you think that more interactivity will enhance the learning process? In which parts of the course?*
   Suggestions for more interaction are concentrated in the following areas:
   - ✓ In the exercise sections, on-line interaction with the index on key – words must be provided, so that students do not have to navigate to the key word index during the performance of the exercise.
   - ✓ When the above is not sufficient links to appropriate chapter must be provided. This is again another issue to be taken into consideration in the intelligent agents design. An intelligent agent can identify the cases where students are suggested to review a unit again before they continue with the exercise - assignment.
   - ✓ Enhancements on the self assessment sections with explanations and identification of possible causes for mistakes.
   - ✓ In the case study section, a chat facility or discussion board must be provided to allow for more interaction among the students and between students and tutors.
9. *Do you think that it is valued for a student to get feedback directly from the computer, with the aid of intelligent agents?*
   The main benefit of adding intelligent agents in the design of a course ware is the increase of interactivity and the immediate response to student's actions. It is believed that this in turn will help students to stay "on the course", which otherwise could abandon when facing problems and feel that they get no support. A hypothesis that must be tested anyhow.

10. *Overall is INTELLECT a learning resource you feel that you want to use in teaching a database course.*
    The basic points indicated by the tutors are the following:
    - ✓ Students can use it only if the have some level of expertise with the subject before.
    - ✓ It must be used as a supplementary learning aid.
    - ✓ Some of the suggestions made above must be implemented for it to become a practical tool.

## 5. CONCLUSIONS

In this paper we presented the importance of following a well-structured approach for converting text-based material in WEB courseware. With the rush to "get wired" and connected to the Internet, and the associated opportunity it gives education deliverers to use this medium to reach students, it is most timely and important to look at how best to use the net. Just throwing technology at students and hoping that all works well is naive at best. We know from the experience that poorly authored material can offset any advantages the technology might bring. It is thus important to understand:

- how to conduct and manage the process of material production,
- how best to use the available technology (like multi-media and AI),
- of the options available, what is the best way to use which technology for what type of pedagogical outcome.

Tutors see a value in using hypertext materials as a supplementary learning aid, but not as a stand-alone courseware. The overall approach in the design of hypertext as described here is considered efficient. The level of interactivity is a crucial factor in the success (as measured by the degree of access and usage by students) of any hypertext courseware. Enhancements in the form of intelligent agents are considered necessary and can replace the student – tutor interaction. Multimedia features are not always necessary, however enrichment with external links and real world applications can provide significant added value to the material.

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