Authoring Hypermedia Training Applications

A. Tsalgatidou[1], M. Anastasiou, D. Plevria, M. Hatzopoulos

Dept. of Informatics, University of Athens,
Panepistimiopolis, TYPA Buildings
Ilisia 157 71, Athens, Greece

ABSTRACT

This paper presents an approach for authoring training applications. In this approach we think an author can undertake two roles: the meta-authoring role and the authoring role. A meta-author selects educational material and proposes lessons to be used later by an author in order to build specific educational applications. These two roles are supported by the meta-authoring tool and the authoring tool, which both form the authoring environment. The system also comprises a repository with generic and re-usable data, and a delivery environment. Resulted applications consist of flexible educational sessions, which are adjustable according to the learner's profile and overcome several problems, such as disorientation, usually encountered in hypermedia applications. Thus, authors can easily and effectively build educational applications, trainees' progress is automatically assessed, and reusability is achieved.

Keywords: hypermedia, educational applications, authoring environments.

1. INTRODUCTION

The last few years the world started rapidly changing from an industrial based society to an information-based society where information is increasingly valued as a major currency of worth. As we move towards this information society the need for changing education practices is becoming more and more intensive. Research and everyday practice highlights the importance of using multimedia in the educational process [14] as the different perceptual means for representing information, such as video, audio or animation provide rich dimensions to process, derive, compose, exchange and store our thoughts and concepts.

The new popular tendency in education is the use of hypermedia applications, where nodes of multimedia information are inter-linked providing in this way a different way for information access. Hypermedia systems that allow a degree of unstructured exploration can facilitate the educational process [7], however, it is not clear how useful they are as they appear to be too open-ended for a novice. On the other hand a choice for organising knowledge in a direct manner with explicit connections prevents a novice from moving in an independent and autonomous manner, and from applying his/her own learning style. It seems that hypermedia systems with a degree of structure built in, but also the options of customised design, may serve as effective bridges to bring readers at a virtual place where they can create more personalised and distinctive organisations of the material available [1].

Therefore, before launching the development of a hypermedia training application a decision has to be made about the educational guidelines to be followed in the educational process, the learning styles to be adopted and the audience to be supported by the system. Appropriate authoring tools should be provided to support and facilitate such a process.

This paper presents an approach for building hypermedia training applications which attempts to overcome the aforementioned problems by integrating appropriate authoring tools and a generic repository in an environment called HILDE[2]. This approach is presented in the following sections as follows: first the overall HILDE approach and environment

[1] E-mail addresses: [afrodite, grad0073, grad0102, mike]@di.uoa.gr

[2] Work for HILDE has been partially supported by the Commission of European Communities (CEC) and the Greek General Secretariat for Research and Technology (GSRT).

are described; then the functionality of the provided authoring tools is analysed followed by a description of the delivered application and environment; related work is then presented and compared with the HILDE approach and finally some conclusions are drawn and future work is discussed.

2. THE APPROACH AND THE AUTHORING ENVIRONMENT

2.1 The Approach

HILDE aims at the development of applications for autoinstuction or/and distance learning. The requirements set and satisfied by the HILDE approach for these applications are: to guide a trainee throughout the educational process, to dynamically change the level of difficulty of the courses depending on trainee's needs and knowledge level and at the same, to offer trainees the possibility of navigation.

In order to support the requirement for flexibility and adaptation to the learner's needs, the HILDE platform offers an author facilities to determine trainee stereotypes and educational strategies. Stereotypes of trainees are descriptions of their expertise on a specific topic e.g. novice, expert, or average. Educational strategies determine the type of presentation and the kind of exercises that are appropriate for a specific trainee stereotype. There are three alternative forms of presenting the context of a lesson: analytical, normal and concise. After theory presentation of each lesson, there are a number of exercises that a trainee has to do. Exercises have various difficulty levels. There are easy, average and difficult exercises. There is a strong relation between the theory presentation and the difficulty of the exercises to be asked. More specifically, an analytical theory is followed by easy-to-solve exercises, a normal theory is followed by exercises of average difficulty, and a concise theory is followed mainly by difficult exercises. A more concise description of these concepts is as follows:

educational strategy := presentation_type + type_of_exercise + trainee_stereotype
presentation_type := [analytical, normal, concise]
type_of_exercise := [easy, average, difficult]
trainee_stereotype := [novice, expert, average]

During a training lesson, trainee's behaviour is captured by her/ his answers to the exercises provided, and his/her stereotype is assessed. According to this new stereotype, the current theories' presentation as well as the educational strategy incorporated in the application, the level of training for the next lesson is adjusted; i.e. presentation of the lesson changes and the kind of exercises presented is redefined [17].

It has to be mentioned here that, there are contradictory aspects about whether a trainee should be free to explore a hypermedia network or not. This issue is even more difficult to be dealt with as far as educational hypermedia is concerned. Researchers [6, 20] suggest that the experience of many alternative pathways becomes a source of confusion and frustration for trainees. On the other hand, there also exists the opinion that "a form of organisation that only allows a novice to search through direct and explicit connections do not facilitate the development of that novice into an independent and autonomous reader" [1].

The approach we take here is to provide a degree of structure to the information provided, which facilitates both the users of the authoring environment and the user of the final application. This structure on one hand aids an author to organise knowledge as soon as it is inserted facilitating in this way the application development process, and on the other, it provides a form of guidance to the learner. At the same time, the existence of hyperlinks allows a certain degree of navigation. This is more clarified in the following section.

2.2 The Authoring Environment

The authoring environment is part of the HILDE platform. This platform supports the development of generic as well as specific hypermedia training applications. The HILDE platform, apart from the authoring environment comprises the delivery environment, which is analysed in section 4. More details about the HILDE architecture and approach can be found in [23].

In the concept of the HILDE approach, the authoring environment provides tools to support the activities and tasks of two kinds of roles: the *meta-authoring role* and the *authoring role.* The meta-authoring role encapsulates the tasks of organising and storing knowledge of a scientific domain in order to create educational material and organise it into a logical context so that it can be subsequently re-used for the development of specific training applications. The authoring role encapsulates the tasks of formation of specific educational sessions of lessons, the definition of the way the information will be presented, and the educational strategy to be applied, thus creating the final application. These two roles are supported respectively by a meta-authoring tool and an authoring tool, which together with a repository of generic data, form the authoring environment.

The repository of generic data is a database containing generic knowledge about scientific domains as well as training scenarios and authors profiles. Knowledge in the repository is organised as an hierarchy of concepts as follows: at the top is the concept of science; sciences consist of science fields; science fields consist of educational sessions; educational sessions contain lessons (see figure 1). Each lesson is connected to a number of theories, exercises, and multimedia assets. Theories, exercises, and multimedia assets are also stored in the repository but separate from the above-mentioned hierarchy, which actually contains the links to the actual information. A meta-author inserts educational material in the repository, forms lessons and proposes educational strategies and scenarios to be used for the application presentation. An author in turn chooses items from the database and forms specific educational sessions with specific scenarios and strategies.

In the following we describe the functions of the meta-authoring tool and the authoring tool. In practice, a meta-author and an author is usually the same person. However, since these two roles are conceptually distinct, we separate them.

3. THE AUTHORING TOOLS

HILDE comprises two authoring tools: the meta-authoring tool and the authoring tool. Both the meta-authoring tool and the authoring tool were built in MS-Windows NT 4.0 environment. We used Microsoft Visual Basic 4.0 Enterprise Edition to implement the meta-authoring tool, and the Multimedia Toolbook 4.0 to implement the authoring tool. Database's schema is stored in Oracle Server. The communication between each of the tools and the repository is achieved through ODBC connection between the Oracle Server and the clients sited on the machines where the tools run.

3.1 Meta-authoring tool

The meta-authoring tool is the core of the authoring environment. This tool gives a meta-author the ability to construct / propose educational sessions that correspond to the corporation's aims and purposes, or to the school's needs.

As the meta-author incorporates multiple theories, multimedia assets, questions and answers into lessons, s/he is given quite a freedom to develop her/his own initiative. Furthermore, the tool guides him/her through icons and appropriately chosen display techniques to edit, name and give attributes to the various multimedia items as well as to place them in the appropriate position.

The educational material needs to be organised into categories, according to the abstraction level the educational session under development belongs, i.e., which science and which science field it is concerned with. The meta-author defines the scientific domains that the material may be associated with, adding in this way a degree of structure into the system and facilitating the lessons' creation phase.

Subsequently, the authors use the lessons in order to form a final application. We specifically support the role of the meta-author in order to ensure coverage of various scientific domains by storing relevant information in a generic repository and in order to encourage reusability of educational material by offering the possibility to re-use, re-edit and re-format existing lessons and multimedia assets. The notion of reusability is important, as the meta-author can reuse (a) a lesson of one educational session into another, and (b) multimedia assets, theories and exercises existing in the repository to create new structures in the hierarchy to form new lessons, educational sessions etc.

Various facilities are provided for flexible customisation of the user interface of the target application. A meta-author has the opportunity to interact with the tool in order to form alternative kinds of theory presentation (concise, normal, detailed). He can determine a difficulty level for the questions as well as a percentage for the correctness of the answers, form diagnostic messages, and suggest alternative ways for customisation of the user interface of the training application according to the

trainees' progress. In other words, s/he forms educational strategies that are stored in the repository to be used by the author for the creation of specific training applications using the authoring tool, which is described below.

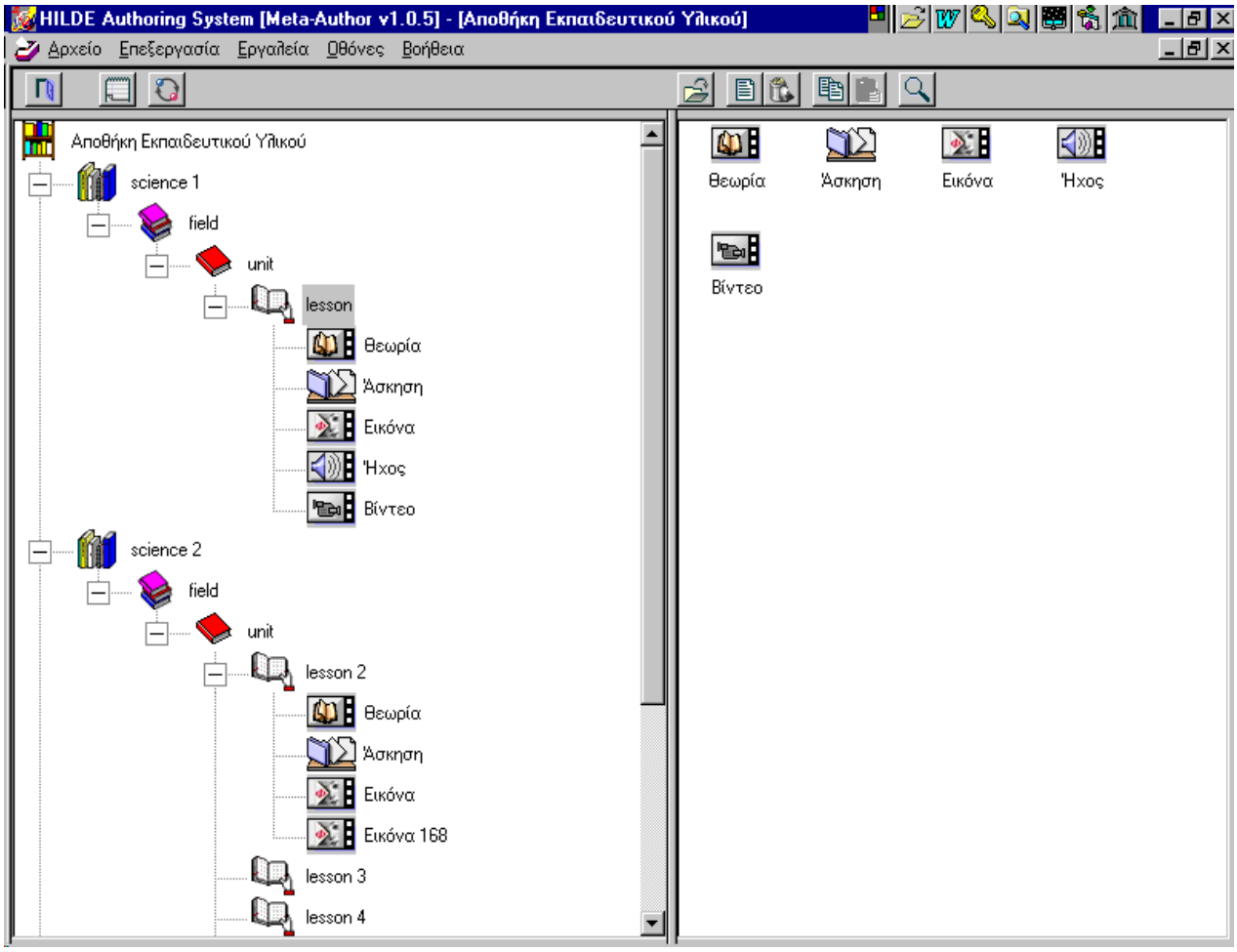

Figure 1: The main screen of the meta-authoring tool.

3.2 The Authoring Tool

After the meta-author has introduced material in the repository, an author can build educational applications using the authoring tool. An executable educational application consists of a number of sessions of lessons on a specific educational domain. An author can use the lessons proposed by a meta-author either as they are or after adding in / cutting out some items. The authoring tool's graphical environment facilitates an author either to select and edit material from the repository or to introduce new material.

Figure 2 depicts the first page of the authoring tool. There are menu style dialogs as well as "function keys". An author can directly see the repository hierarchy and select items either by clicking at the appropriate node or by drag and drop operations.

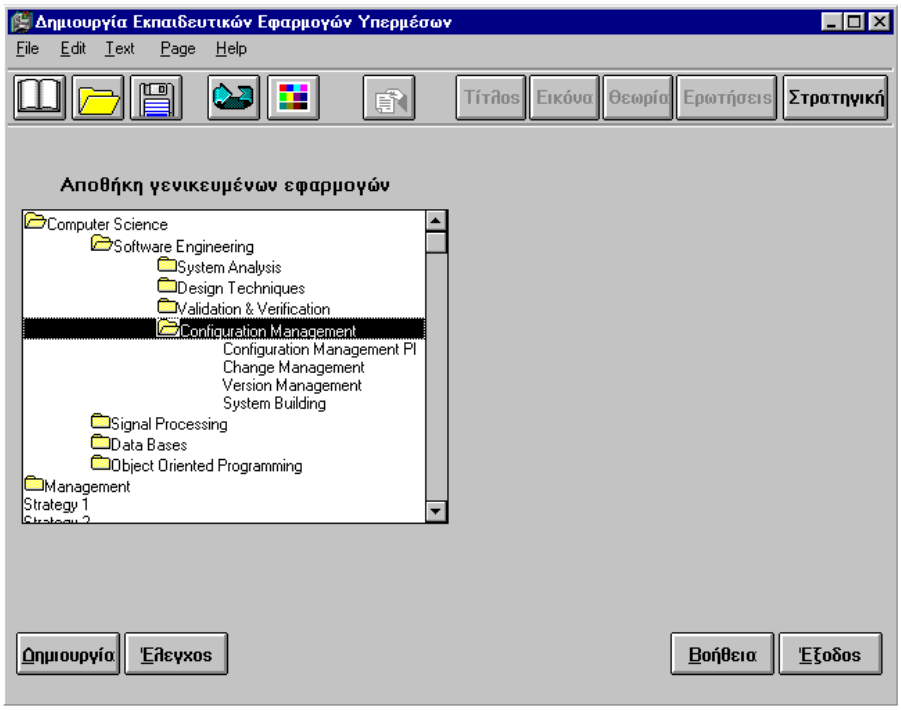

Figure 2: The first screen of the authoring tool

One of the first tasks of an author is to decide which educational strategy will be incorporated in the educational application under construction. An author either selects a strategy from the ones already introduced by a meta-author or s/he suggests a new one. Following, an author selects lessons' theories in a way that also determines their flow in the application. The tool provides trainees with a preordered series of theories in order to avoid the well-known disorientation problem, which creates problems in the educational process. Similarly to theories' selection, an author has to select exercises on these theories. These exercises are of various difficulty levels and are raised to trainees at the end of each lesson.

Another important task of an author during the construction of the final application is the design of the presentation screens. The careful design of the presentation with the enhancement of multimedia material can speed up the assimilation of concepts by trainees and make the final application more interesting and friendly. Currently, the authoring tool provides an author with a number of preconstructed forms of presentation, from which s/he can choose and customise.

The notion of reusability is also important for an author, as s/he can reuse (a) multimedia assets to prepare and design various presentation screens, (b) theories and exercises in different lessons, and (c) strategies to build different educational applications.

After theories and question selections and the design of the presentation, a final application is produced either in tbk format (toolbook application) or html format (Internet application).

4. THE HILDE APPLICATION REACHES THE TRAINEE

The delivery environment comprises an interface module, the object base, the storage of user profiles, as well as processes for customising the interface and assessing the trainee (see figure 3).

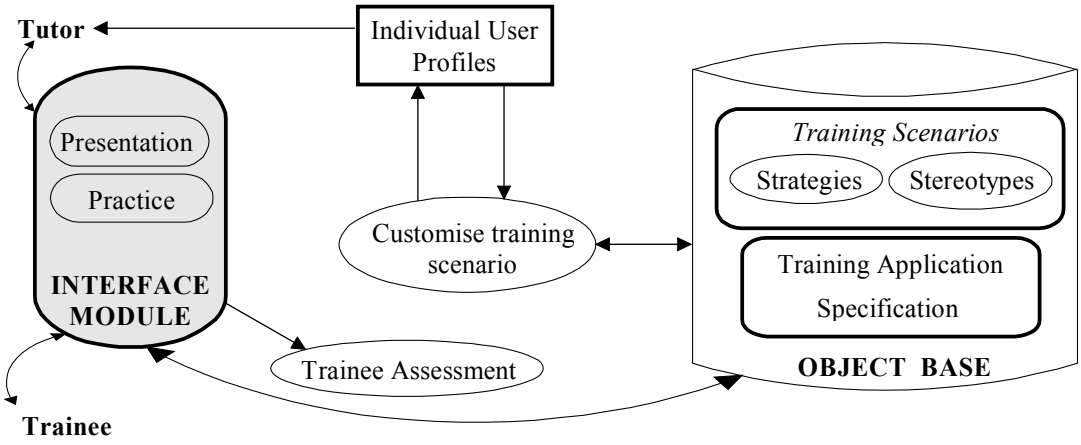

Figure 3: The Delivery Environment

The specification of the application as well as the training scenarios to be used is stored in the object base. An educational session is being presented through the interface module, which also aids the trainee to practice his/her knowledge through exercises. General and individual information about trainees such as name, password, progress, individual stereotype, and point of interruption of the session are being stored into the individual user profiles module. The trainee's progress is automatically assessed, and the corresponding stereotypes are updated. Apart from the trainee, a tutor can also interact with the application as a response to trainees' request for help and advice.

The application attains good usability: The trainee can learn about a topic using the HILDE application, through which s/he experiences audio, video, and other multimedia facilities. During tutoring, s/he follows educational sessions of courses, and practices the acquired knowledge by working out several exercises. By using the provided hyperlinks between exercises and corresponding theories as well as between a key-word of a theory and another one, s/he can navigate through the theories' presentations whenever s/he needs an explanation or a refreshment of knowledge. In this navigation process, the possibility to go back to the starting/central point, which is the current lesson, is preserved.

5. RELATED WORK

Multimedia (& hypermedia) is used in many application areas such as conferencing [18], [11], collaborative work [16], [8], art [10], technical presentation [2], etc. Here, we examine the use of multimedia & hypermedia in the area of training and education. Learning could be facilitated by the use of hypermedia, because their structure is similar to the way knowledge and concepts are organised in human memory [7].

In the following, we examine the origins of HILDE, then we review some work on educational applications and finally we examine some authoring environments.

HILDE can be considered as the successor of HTAS [24] system and MTDE [25] system. The architecture proposed by HILDE for the authoring and the delivery environment is analogous to the ones proposed by HTAS. Our work on HILDE repository and multimedia assets handling was influenced by MTDE, which provides a framework for assigning hypermedia functionality to multimedia assets, and suggests the construction of an asset Repository and integrated tools. In addition to these characteristics, HILDE implements particular educational strategies and provides specific ways and flexible possibilities to the authors to form lessons and assign to them specific characteristics useful in a training process. HILDE also adapts the notions of "Authoring-in-the-large" and "Authoring-in-the-small" introduced by the general-purpose model for hypertext development HDM [9] and uses them in a similar generic notion for the authoring of generic applications using the meta-authoring tool as well as of specific multimedia applications using the authoring tool.

As an environment for the production of educational applications HILDE can be related to educational applications. A different approach from the HILDE one is "La Plaza" application [13] that assists students to develop certain skills, such as

exchanging experiences, opinions, writing stories etc. This comprises the storage of multimedia data without central point, and the arbitrary insertion of information. There are also ready-to-use teaching environments for a specific knowledge domain, such as MUG [5], PsyCLE project [12], PianoForte system [21] and Perseus project [15]. These are specialised hypermedia environments which neither enable the domain expert to intervene and compose lessons, nor they promote reusability.

HILDE can also be related to many authoring environments, which focus on different aspects than HILDE. Examples of such hypermedia authoring environments are: SEPIA [22], MAEstro [4], Multicard [19], and Microcosm [3]. SEPIA is a hypermedia system that supports co-operative authoring. The main concern of SEPIA is to facilitate the production of hypermedia document by a distributed group of people. MAEstro is a distributed, multimedia authoring environment for creating multimedia documents. Main concern of this environment is to deal with problems in the area of synchronisation posed by the distributed nature of multimedia authoring. Multicard is a hypermedia system which offers an authoring / navigation tool, a scripting language and a multimedia composition editor. The main feature of Multicard is M2000 communication protocol that provides a means for stand-alone applications to be considered as an integral part of the system. Microcosm is an open hypermedia system that made a move towards the new generation of hypermedia. It can be viewed not only as a hypermedia authoring or presentation system but also as an extension to an operating system. It introduces the separation of links from data objects into a link database. A similar approach for handling links between objects is used in MTDE and in HILDE. In Microcosm, filter processing provides all link functionality.

The main difference between HILDE and these environments is that HILDE approach concentrates on providing authoring facilities for the efficient organisation of educational material, on promoting re-usability of existing components and on the production of usable specific educational applications.

6. CONCLUSIONS

The work presented here contributes to the hypermedia area and the area of education and authoring. It satisfies most of the requirements set at the introduction of the paper. More specifically, it enables the building of training applications which attain good usability, high interactivity, provide navigation facilities to the learners, offer guidance during the courses, and are flexible in the sense that they offer adaptation to the learner's needs. The careful design of the presentation succeeds in providing a helpful interface, which does not create disorientation problems to the learners. The building of such applications is accomplished due to the HILDE approach and the specific characteristics of the HILDE environment and the authoring tools, which promote the notions of genericity of the repository and re-usability of the application's components.

The final version of the platform will be distributed to several organisations and schools, so that they develop training applications in a real-world environment. Feedback from their side will be extremely helpful for the assessment of the facilities that the environment offers in the course of the development phase, as well as during the process of training. Subsequently, we will investigate the necessity of further improving the environment in order to promote the creativity of authors and possibly modify the degree of freedom provided to trainees.

ACKNOWLEDGEMENTS

We would like to thank the rest of the participants of the HILDE project for their contribution in this work, and particularly the project manager M.Panayiotou, and ATC for their contribution to the implementation of the meta-authoring tool.

REFERENCES

1. Burbules N. & Callister T., «*Knowledge at the Crossroads: Some Alternative Features of hypertext Learning Environments*». Published and copyrighted by EDUCATIONAL THEORY, Winter 1996, http://www.ed.uiuc.edu/coe/eps/papers/crossroads.1.html
2. Cruz G., and Hill R., «Capturing and Playing Multimedia Events with STREAMS», *ACM Multimedia 95 Proceedings*, pp. 193-200*,* ACM Press, San Francisco, Nov. 1995.
3. Davis H., Hall W., Heath I., Hill G., «Towards An Integrated Information Environment With Open Hypermedia Systems», *Proceeding of the ACM Conference on Hypertext*, Lucarella D., Nanard J., Nanard M., Paolini P. (ed.), pp. 181-190, ACM Press, Milano, Dec. 1992.
4. Drapeau George D., «Synchronisation in the MAEstro Multimedia Authoring Environment», *Proceeding of the conference on Multimedia '93*, pp. 331-339, Anaheim, CA, 1993.
5. Eco U., «Hypermedia for Teaching and Learning: A Multimedia Guide to the History of European Civilization (MuG)», *Proceeding of the ACM Conference on Hypertext*, Lucarella D., Nanard J., Nanard M., Paolini P. (ed.), pp. 288, ACM Press, Milano, Dec. 1992.
6. Edwards Deborah, Wardman Lynda, «'Lost in Hyperspace': Cognitive mapping and navigation in hypertext environment». In: Mc Aleese, ed, Hypertext: Theory into Practice, pp.105-125.
7. Eklund, J., «Cognitive models for structuring hypermedia and implications for learning from the world-wide web» , 1996, http://www.scu.edu.au/sponsored/ausweb/eb95/papers/hypretext/eklund/index.html
8. Gajewska H., Kistler J., Manasse M., Redell D., «Argo: A system for Distributed Collaboration», *ACM Multimedia 94 Proceedings*, pp. 433-440, ACM Press, San Francisco, California, October 1994.
9. Garzotto F., Paolini P., «HDM - Model -Based Approach to Hypertext Application Design». In *ACM TOIS*, 11 (1), pp. 1-26, Jan. 1993.
10. Gold Rich (panel organiser) «Artists in multimedia: creating meaningful roles*», ACM Multimedia 94 Proceedings*, pp.287-288, ACM Press, San Francisco, California, October 1994.
11. Imai T., Yamaguchi K., Muranaga T., «Hypermedia Conversation Recording to Preserve Informal Artifacts in Realtime Collaboration», *ACM Multimedia 94 Proceedings*, pp. .417-424, ACM Press, San Francisco, California, October 1994.
12. Hammond A., McKendree J., Reader W., Trapp A., «The PsyCLE Project: Educational Multimedia for Conceptual Understanding», *ACM Multimedia 95 Proceedings*, pp. 447-456*,* ACM Press, San Francisco, Nov. 1995.
13. Hepp P., Rehbein L., Hinostroza E., Laval E., Dreves C., Ripoll M., «Enlaces Amultimedia Based Educational Network». *ACM Multimedia 94 Proceedings*, pp. 329-336, ACM Press, San Francisco, California, October 1994.
14. Large A., Behesti J., Bruleux A., Renault A., «The influence of Multimedia on Learning: A cognitive study», *ACM Multimedia 94 Proceedings*, pp. 315-319, ACM Press, San Francisco, California, October 1994.
15. Marcionini G., Crane G., «Evaluating Hypermedia and Learning: Methods and Results from the Perseus Project*», ACM TOIS*, Volume 12 (1), pp 5-34, January 1994.
16. Nardi B., «Collaborative multimedia: getting beyond the obvious», *ACM Multimedia 94 Proceedings*, pp. 119-120, ACM Press, San Francisco, California, October 1994.
17. Panagiotou, M., «Students' cognitive and knowledge quality model». Ph.D. Thesis, University of Athens, Dept. of Informatics, 1996.
18. Rangan V., Vin H., «Multimedia conferencing as a Universal Paradigm for Collaboration», *Multimedia Systems, Applications and Interaction*, chapter 14, Lars Kjelldahl (editor), 1991.
19. Rizk A., Sauter L., «Multicard : An open hypermedia System», *Proceeding of the ACM Conference on Hypertext*, Lucarella D., Nanard J., Nanard M., Paolini P. (ed.), pp. 4-10, ACM Press, Milano, Dec. 1992.
20. Rouet Jean-Francois, «Cognitive Processing of Hyperdocuments: When Does Nonlinearity Help?», *Proceeding of the ACM Conference on Hypertext*, Lucarella D., Nanard J., Nanard M., Paolini P. (ed.), pp. 131-140, ACM Press, Milano, Dec. 1992.
21. Smoliar S. W., Waterworth J. A., Kellock P. R., «pianoFORTE: A System for Piano Education Beyond Notation Literacy*», Proceedings ACM Multimedia 96*, pp. 457-465, ACM Press, San Francisco, Nov. 1995.
22. Streiz N., Haake J., Hannemann J., Lemke A., Schuler W., Schütt H., Thüring M., «SEPIA: a Cooperative Hypermedia Authoring Environment», *Proceeding of the ACM Conference on Hypertext*, Lucarella D., Nanard J., Nanard M., Paolini P. (ed.), pp. 11-22, ACM Press, Milano, Dec. 1992.

23. Tsalgatidou A., Plevria D., Anastasiou M., Hatzopoulos M., "HILDE: A Generic Platform for Building Hypermedia Training Applications", "*Advances in Information Technologies: The Business Challenge*", Proceeding of the EMMSEC'97, J.-Y. Roger, B. Stanford-Smith and P. T. Kidd (Eds), pp. 469-476, IOS Press, 1998, Florence, Italy, 3-5 Nov, 1997.
24. Tsalgatidou A., Palaskas Z., Halatsis C., Hatzopoulos M., «An Integrated and Customisable support system for building Hypermedia Training Applications», *Proceedings of DEXA'94*, D. Karagiannis (ed.), pp. 540-549, SPRINGER-VERLAG, 1994.
25. Tsalgatidou A., Halatsis C., Spiliopoulou M., Hatzopoulos M., «A Multimedia Title Development Environment (MTDE)», *Information Processing & Management*, **31** (1), pp. 101-112, 1995.